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The Mysore Agricultural Journal

(The Organ of the Mysore Agricultural and Experimental Union)

Vol. XXII] JANUARY—MARCH 1944 [No. 3

A Brief Review of the Methods adopted in Rural Parts and the Experiments and Observations made in India, in the Matter of Storage of Food Grains

BY

B. KRISHNAMURTHY, B.Sc., F.R.E.S., AND D. SESHAGIRI RAO, B.Sc.

1. INTRODUCTION

The problem of protecting food grains and other products from insect attack and damage while in storage is engaging the serious attention of Entomologists in India from a long time. In the course of a variety of investigations, a survey of the methods of storage as practised by ryots and grain merchants has been made; several of these indigenous methods have also been tested in the laboratory with a view to improving upon them, having due regard to the economic condition of the average Indian villager. Experiments have been conducted and careful observations made on the habits and life-histories of store pests and their reactions to different methods of storage; important data on these lines have been gathered which have to be given due weight in any consideration of the subject of storage of food grains.

2. PREVALENT METHODS OF STORAGE

It is generally only in rural parts that various simple devices for storing grains for a year (harvest to harvest) or longer are met with. A brief account of different methods of storage adopted in this country with special reference to Mysore is given below:

(*a*) *Storage Pit.*—This simple method of storing grains has reference to underground pits, about 6 to 10 feet deep and 2 to 3 feet in diameter, known as "Hagevus" (ಹಗೇವು). These excavations are of two types,—those dug inside houses (often in the inner yard) having the inside surface plastered over with mortar or cow-dung slurry, and those situated in the fields (on high ground) which are not plastered inside. When filled up, they are closed with stone slabs or burnt clay lids, and cemented on firmly with wet clay plugged all round.

The bottom and sides of the pit are generally lined with straw or leaves of certain plants like "Lakki" (ಲಕ್ಕಿ—*Vitex negundo*) before the grain is poured inside and a layer is also spread on top. The grain is withdrawn occasionally, or left intact for a period of five or six years, as the case may be.

(*b*) *Earthenware Receptacles.*—Pots of baked clay of various shapes and sizes are commonly used for storage. Two types of these receptacles have been recognised: one, the earthenware pot of the usual shape, holding from a few seers to about a palla, called "Gudanas" (ಗುಡಾಣ). These are not used for bulk storage but for storing various sundry items like spices and jaggery. The other type is the bigger jar-shaped structure called "Vadai" (ವಾಡೆ) open at top and

bottom, with a capacity upto ten pallas; they are also built in two pieces, one fitting over the other. They are installed inside the houses usually on pials with wet clay plugged between the bottom rim and floor, and when filled, a circular earthenware lid is put on and sealed with wet clay.

(*c*) *Bamboo Structures.*—Containers made of split bamboo matting smeared over with mixture of cowdung and earth and mucilage and of various sizes and shapes are also employed. A cylindrical pattern without bottom with a capacity upto ten pallas, called "Pettay" (ಪೆಟ್ಟಿ), is commonly used for storing paddy. Another type is a flask-shaped structure with a narrow neck from which grain is drawn through an aperture at the bottom closed with a cocoanut shell. In certain parts, a cylindrical or rectangular store is constructed out of thick bamboo matting, raised above the ground by supports at the corners, plastered and whitewashed outside and provided with a sloping roof of wooden boards. Cylindrical bamboo-matting bins with a conical roof of thatch are also found in some areas.

Date-leaf matting is also used in many localities for making storage bins.

(*d*) *Straw Baskets.*—These are spherical structures made of plaited straw and supported by ropes tied round them, known locally as "Moodais" (ಮೂಡೆ). Their capacity is necessarily small and as it requires great labour to build them, their use is restricted to the storage of seed material, chiefly pulses.

(*e*) Storage Cellar.—A common method of storage is in cellars, built above or below the ground in some part of the house plastered inside and fitted with wooden trap-doors either in the side-wall or on the flat roof. They are known as "Kanajas" (ಕಣಜ). The grain is heaped on the ground generally on a date-mat or a bed of straw.

The grains stored in cellars are more liable to be damaged by rodents than in other forms of storage.

(*f*) Storage in gunny bags and bags of date-matting.

3. Treatment of Grains Prior to Storage

Certain simple methods of treatment of grains based on tradition and experience, some of which having a degree of scientific backing are in vogue among the ryot population and are briefly mentioned here:

(*i*) Sun-drying.

(*ii*) Mixing some inert material like sand, ashes, lime powder, ragi husk, etc., with the grain.

(*iii*) Smearing the grain with castor oil and other edible oils or with red earth paste.

(*iv*) Keeping small quantities of various foreign substances, such as camphor, asafœtida, garlic, sulphur and mercury in the body of the grain.

(*v*) Storing pulses under ragi or savai. Pulse pests do not attack ragi or savai.

4. Experiments and Observations

(*a*) *Experiments on storage receptacles.*—Storage experiments on a laboratory scale have been conducted with certain types of storage vessels—earthen pots, gunny bags, and bamboo bins with stoppered glass jars for comparison, and accessibility to insect attack and the condition of the grains and insect popula-

tions studied at various intervals after storage. The nature of the experiments and observations made on this aspect of the subject are dealt with briefly here.

The following table gives the comparative loss in weight of stored grains (wheat and rice) stored for varying periods in different receptacles:—

TABLE I

Loss in Weight of Stored Grains

	Receptacle	Grain	Quantity	Period of storage	% of loss in weight	Remarks
			lbs.	months		
1.	Stoppered jar	Wheat	2	9	6	
	Earthen pot (with cover) ..	,,	2	9	39	
	Gunny bag	,,	2	9	39	
2.	Stoppered jar	,,	1	6	9	Experimentally infested
3.	Gunny bag	,,	4	6	37	
	do.	,,	4	10	70	
4.	Earthen pot	,,	25	7	31½	Cover plastered
	do.	,,	25	10	54½	over with mud
5.	do.	,,	25	7	22	Cover loose
	do.	,,	25	10	33¾	
6.	do.	,,	25	7	30½	
	do.	,,	25	7	28	Cover plastered
	do.	,,	25	7	75½	over with mud
	do.	,,	25	7	71½	
	do.	,,	25	7	12	
7.	Gunny bag	,,	160	7	16	
	do.	,,	160	10	26	
8.	Earthen pot	Rice (par-boiled)	2	9	15	
	Gunny bag	,,	2	9	18	
9.	Earthen pot	,,	25	7	2	
	do.	,,	25	10	2¾	
	do.	,,	25	20	4	
	do.	,,	25	24	4½	

The above table shows that storage in either gunny bags or earthen pots renders grain liable to considerable damage by insects, the loss increasing with the period of storage; the actual amount of damage naturally depends on a variety of factors. Plastering the covers of earthen pots with mud does not protect the contents, insects being able to bore inside.

Observations on storage in underground pits, cellars, bamboo bins and baskets in their natural condition in the villages have been made; none of those is entirely insect-proof. Other disadvantages are also noticed.

(*b*) *Experiments on Treatment of Grains*: (*i*) *Drying Grains before Storage.*—Simple sundrying of wheat for full three days to reduce the moisture content to zero was done, weevils introduced, and the grain stored in stoppered jars. It was kept under observation for nearly three years, being examined periodically, once in about six months. The grain was found unaffected and the weevils were all dead. More weevils were put in after each examination; of the four trials set up, two were opened occasionally to allow the grains to absorb moisture from the atmosphere and these seeds germinated satisfactorily when tested at the end of six months. The germinating power in the other two sets, which were not opened occasionally was entirely lost.

Experiments on superheating in order to determine the range of lethal temperatures for store pests have been conducted in the Punjab. Temperatures ranging from 50° C. to 100° C. were found lethal, but the lower temperature required a considerably longer period of exposure. Thus under 50°-51° C., an exposure period of five hours was found necessary to kill larvæ of *Trogoderma khapra*, while under 85° C. to 100° C. only 30 seconds sufficed.

Other experiments in this direction have shown that if there should be more than a minimum amount of moisture in stored grain (for example about 8 per cent. for cereals) it becomes susceptible to attack.

(*ii*) *Mixing Some Inert Material with Grains.*—The effect of mixing various cheap and commonly available stuff like powdered lime, sand, vitex (ಲಕ್ಕಿ) leaves, neem leaves, ashes, road dust and paddy husk with the grains has been tested with the following results:—

TABLE II

Effect of Mixing Certain Materials with Grains

Receptacle	Grain	Quantity	Inert material used	Period of storage	% of loss of weight	Remarks
		lbs.		months		
1. Stoppered jar	Wheat	2	Lime	9	9	
Earthen pot ..	,,	2	,,	9	36	
Gunny bag ..	,,	2	,,	9	33	
2. Stoppered jar	,,	2	Sand	9	9	
Earthen pot ..	,,	2	,,	9	15	
Gunny bag ..	,,	2	,,	9	33	Control (no treatment)
3. Stoppered jar	,,	2	Lakki leaves	9	9	Stoppered jar 6
Earthen pot ..	,,	2	,,	9	39	Earthen pot 39
Gunny bag ..	,,	2	,,	9	51	Gunny bag 39
4. Earthen pot ..	,,	2	Ashes	9	36	
Gunny bag ..	,,	2	,,	9	42	
5. Earthen pot ..	,,	2	Road dust	9	33	
6. Stoppered jar	,,	1	Neem leaves	6	9	Same percentage of loss in control
do.	,,	1	,,	10	15	
7. Earthen pot ..	,,	4	,,	6	34½	Control 50% loss
do. ..	,,	4	,,	10	75	for 10 months
8. Gunny bag ..	,,	4	,,	6	40½	37½ in control
do. ..	,,	4	,,	10	75	70½ ,,
9. Earthen pot ..	,,	25	Fine sand	10	2	
do. ..	,,	25	Coarse sand	6	5½	
do. ..	,,	25	,,	10	15	
do. ..	,,	25	Road dust	6	66½	
do. ..	,,	25	,,	10	70¼	
do. ..	,,	25	Ashes	6	24	20 in control
do. ..	,,	25	,,	10	31	34 ,,
10. Earthen pot ..	Rice (par-boiled)	2	Lime	10	6	
Gunny bag ..	,,	2	,,	10	6	
11. Earthen pot ..	,,	2	Sand	10	9	Control
Gunny bag ..	,,	2	,,	10	18	Earthen pot 15
						Gunny bag 18
12. Earthen pot ..	,,	2	Lakki leaves	10	12	
Gunny bag ..	,,	2	,,	10	18	
13. Earthen pot ..	,,	2	Paddy husk	10	15	
Gunny bag ..	,,	2	,,	10	24	

Experiments on the use of sand (fine) spread on top of the grain instead of being mixed with it were conducted with the interesting results given below :—

TABLE III

Results of Treatment with Sand as Top-dressing

Receptacle	Grain	Quantity	Treatment	Period of storage	% of loss in weight	Remarks
		lbs.		months		
1. Earthen pot ..	Wheat	25	Covered with a layer of fine sand	10	nil	Control 25½%
2. do. ..	,,	25	Do. (cloth between grain and sand)	10	nil	
3. Gunny bag ..	,,	160	Fine sand mixed with grain	10	10	Control 23%
4. Iron bin ..	,,	800	Covered with a layer of fine sand	10	nil	
5. do. ..	,,	800	Do. (cloth between grain and sand)	10	nil	

Extended observations have shown that the admixture of sand, ashes, Ragi husk, etc., with the grain has no protective value.

(*iii*) *Smearing Grain with Vegetable Oils.*—The results of experiments conducted to find out the effect of smearing grains with oil are given in Table IV.

TABLE IV

Effect of Smearing Grains with Oils

Receptacle	Oil used	Period of storage	% of loss of weight	Remarks
		months		
1. Stoppered jar ..	Castor oil	9	6	
Earthen pot ..	,,	9	36	
Gunny bag ..	,,	9	42	
2. Stoppered jar ..	Cocoanut oil	9	nil	2 lbs. wheat stored in each case
Earthen pot ..	,,	9	42	Control (no treatment)
Gunny bag ..	,,	9	45	Stoppered jar .. 6% loss
3. Stoppered jar ..	Sesamum oil	9	3	Earthen pot .. 39 ,,
Earthen pot ..	,,	9	39	Gunny bag .. 39 ,,
Gunny bag ..	,,	9	39	
4. Stoppered jar ..	Ippe oil	9	nil	
Earthen pot ..	,,	9	39	
Gunny bag ..	,,	9	42	
5. Gunny bag ..	Castor oil	10	15	
do. ..	Cocoanut oil	10	24	160 lbs. wheat stored in each case
do. ..	Sesamum oil	10	20	Control .. 28% loss
do. ..	Ippe oil	10	10½	
do. ..	Groundnut oil	10	16½	
6. Earthen pot ..	Castor oil	9	6	
Gunny bag ..	,,	9	15	
7. Earthen pot ..	Cocoanut oil	9	18	
Gunny bag ..	,,	9	21	2 lbs. rice (parboiled) stored in each case
8. Earthen pot ..	Sesamum oil	9	12	Control
Gunny bag ..	,,	9	12	Earthen pot .. 15% loss
9. Earthen pot ..	Ippe oil	9	24	Gunny bag .. 18 ,,
Gunny bag ..	,,	9	12	
10. Earthen pot ..	Groundnut oil	9	18	
Gunny bag ..	,,	9	12	

The practice of smearing castor oil particularly on the top layers of the grain has been investigated; its efficacy in preventing insect attack can be attributed, in the case of Bruchids attacking pulses to the faulty adherence of the egg to the seed. Eggs deposited on treated seeds do not hatch and even if they hatch, fail to furnish the larva with the necessary support that it needs for boring into the seed.

5. Storing Grains with Small Quantities of Common Insecticidal Substances like Camphor, Asafoetida, Sulphur and Naphthalene

Table V gives the results of experiments under this treatment.

Table V

Effect of Certain Insecticidal Substances on Store Pests

Receptacle	Substance used	Period of storage	% of loss in weight	Remarks
		months		
1. Stoppered jar ..	Camphor	9	nil	
Earthen pot ..	,,	9	42	
Gunny bag ..	,,	9	42	
				2 lbs. wheat stored in each case
2. Stoppered jar ..	Asafœtida	9	Spoilt	Control (no treatment)
Earthen pot ..	,,	9	33	Stoppered jar .. 6% loss
Gunny bag ..	,,	9	42	Earthen pot .. 39 ,,
				Gunny bag .. 39 ,,
3. Stoppered jar ..	Sulphur	9	9	
Earthen pot ..	,,	9	51	
Gunny bag ..	,,	9	48	
4. Gunny bag ..	Camphor	10	25	160 lbs. wheat in each case
do. ..	Naphthalene	10	28¾	Control .. 28% loss
5. Earthen pot ..	Camphor	9	nil	
Gunny bag ..	,,	9	24	
6. Earthen pot ..	Asafœtida	9	12	2 lbs. rice (parboiled) in each case
Gunny bag ..	,,	9	18	Control
7. Earthen pot ..	Sulphur	9	36	Earthen pot .. 15% loss
Gunny bag ..	,,	9	42	Gunny bag .. 18 ,,

The effect of a small pellet of mercury placed inside the excavated shell of a soapnut in the store on store pests has been investigated. In small jars it had marked effect on the pest, entirely preventing emergence; in larger receptacles, its effect was not so marked, though emergence was reduced by three-fourths. Mercury appears to act only on the eggs and it appears to have no effect on larvæ or pupæ (pulse beetles) probably since these stages are inside the seeds. Even advanced eggs in which larvæ are fully formed are not affected by mercury. The treatment does not affect germination.

6. Fumigation Experiments

Fumigation has been found to be the surest method for freeing grain of all insects. The fumigants tested and commonly used are petroleum, carbon

disulphide, hydrocyanic acid gas, sulphur dioxide, methyl-bromide and chlorosol. This method is, however, very expensive and risky under Indian conditions; for it to be really effective, fumigation has to be done in really air-tight receptacles or chambers, and as the gases employed are highly volatile, explosive and poisonous, great care and vigilance are to be exercised in handling them. Chlorosol is harmless but very costly and petroleum is available easily.

Experiments on fumigation with petroleum were conducted recently with the results shown in the following table:—

TABLE VI

Results of Fumigation with Petroleum

(Dose : 1 Pint for 25 c.ft. of space)

Grain	Quantity	Receptacle	Period of fumigation	Remarks
	seers		hours	
1. Jola	3	Glass jar	48	Pulse beetles and Rice weevils found dead; some Tribolium beetles and rice moth larvæ still alive in broken rice. Germination of Jola and Bengal gram not affected.
2. Wheat flour ..	2	,,	48	
3. Bengal gram ..	2	,,	48	
4. Broken rice ..	2	,,	48	
5. Jola	3	,,	66	Pulse beetles, Rice weevils, Tribolium and Rhizopertha beetles mostly all dead; a very small number alive in jola and broken rice.
6. Broken rice ..	2½	,,	66	
7. Wheat flour ..	1½	,,	48	
8. Jola	5¾	Packed in small gunny bags and shoved into steel fumigation box	48	Large number of Tribolium beetles and Rice weevils issued out of bags and dead in fumigation chamber. A few rice weevils alive; all other insects dead.
9. Broken rice ..	6			
10. Wheat flour ..	3			
11. Bengal gram ..	3¼			
12. Wheat	3¼			

7. CONCLUSION

Insects damaging stored grains and other products take a very heavy toll, and as their destructive activity is mainly hidden from view the seriousness and immensity of the problem is not realised except during days of stress and scarcity, as during the present times.

The question of protecting food grains and other commodities from their insect foes under Indian conditions is beset with very great difficulties; the problem concerns the ryot in the rural parts primarily; then the dealer in grains and lastly the consumer; whatever devices may be evolved, they will succeed in their purpose if only they are simple, cheap and require only such materials for their construction as are available in the village or the nearest market. Further, by tradition and the experience of generations the ryot has knowledge of certain simple and somewhat effective methods in which he has naturally great faith and trust. Any recommendations that may be made as a result of scientific research must, therefore, be based on a proper appreciation of indigenous methods of handling and storage of grains.

From the foregoing brief description of the prevalent methods of storage and experiments and observations made on the subject, it is obvious that every method has its advantages and drawbacks but to classify them in the order of relative immunity to grain from insect attack is not possible as various factors like nature of grain, period of storage, state of infestation prior to storage, environmental and seasonal conditions are all involved individually and collectively as well.

In safe storage of grains, two distinct problems arise: (1) the grain should be rendered free from all stages of pests prior to storage, and (2) it should be kept free from insects after storage. Regarding the first problem storage in rural parts is mostly resorted to soon after harvest so that chances of infestation previous to storage are rather remote (except for field infestation of pulses). There is, however, the danger of imperfect drying due to inclement weather or other conditions. This should be avoided at all costs, as moisture in the stored grain (above a certain minimum) promotes insect attack. Winnowing done to remove chaff also helps to drive away adult Bruchids from pulses.

It is in the matter of storage in godowns, depots and warehouses, where grains are dumped to await transportation or distribution to urban areas that the question of infestation before storage demands serious attention. Such grains may be badly infested in the interval between harvest and arrival in the godown where it may have to lie over sometimes for a considerable period.

The second problem of keeping grains free from pests after storage is closely connected with the storage receptacle and nature of treatment.

Storage Receptacles.—Underground storage, though obviating the necessity for special storage receptacles has the great drawback of moisture seeping into the grain and spoiling it to a certain extent depending on the period of storage and other factors. In consequence, all grains are not stored in underground pits; only ragi and jola generally are. Storage cellars in rural parts are usually stocked with the year's entire requirement of the major grains for the family which are periodically drawn upon; breeding of pests goes on without check inside; storage in earthen pots with covers plastered over, bamboo bins sealed over with mud or having bamboo lids, and straw baskets, renders grains liable to attack sometimes heavily, as can be seen from the tables. The best type of receptacle for small as well as large-scale storage, is, however, a cylindrical bin of the required capacity, made of metal or stout bamboo matting with the top slightly widened out; openings are cut at the bottom for drawing out grain, if made of bamboo-matting, the bin may be coated with paper pulp mixed with mucilage.

Treatment.—The rationale of the indigenous methods of treatment already noted is (1) to render it impossible or difficult for insects to have access to grains by enclosing them in a matrix of neutral or objectionable matter such as sand, dust, ashes, lime, etc., (2) to repel insect attack by inserting strong smelling, volatile, germicidal or other substances in the grain like asafœtida, camphor, sulphur, naphthalene, etc., (3) to introduce a small quantity of poison like mercury inside, which kills developing eggs, and (4) to prevent egg-laying and development by smearing grains with various oils. These various treatments have, no doubt, a degree of usefulness, if properly undertaken but cannot be fully depended upon; it entails much labour to separate grains from sand, ashes, etc.,

mixed with them; sand even gets into the excavations in the grains made by insects; camphor and asafœtida acting as temporary palliatives, evaporate away after some time; mercury is ineffective on stages other than eggs and oils reduce the germinating capacity of grains, besides otherwise spoiling them.

As a result of extended experiments a layer of fine sand spread on top of the grain, two to four inches thick, has been found very satisfactory in protecting the grain below it from insect attack for fairly long periods. The explanation for this simple treatment proving effective is based on the breeding habits of most of the store pests. The adults on emergence from previously infested grains invariably come out to the top of the grain for mating and egg-laying; this instinct is partly due to the close packing of grains which does not allow sufficient room for the adults to seek mates and copulate. After copulation, eggs are generally laid on the top layers of the grain; when a layer of fine sand, two to four inches thick, is spread on top, the adults (such as may emerge inside) may wriggle through the sand to the top (so strong is the instinct) and mate, but are prevented from ovipositing as the sand, interposed between themselves and the grain forms an impenetrable barrier. To prevent sand mixing with the grain a piece of cloth, a sheet of paper or cardboard, a wooden plank or even a metal sheet may be placed on the grain and sand spread over it.

The cylindrical bin referred to above, is provided with a widened-out neck portion to facilitate sand treatment. When the bin is filled a circular plank or sheet is put over the grain and sand spread on it so as to cover the greater width of the neck portion also. A detailed description of the improved model of storage bin will be found elsewhere.

Storage in the bin cannot be resorted to in all cases, especially in large-scale commercial handling when grains may have to be frequently on the move; in such cases only storage in gunny bags is possible and when a consignment has to be stored in a godown for a period of say, longer than two months it is safer to inspect the stock very frequently and subject the bags and the interior of storehouse or godown to spraying with pyrethrum extract (with kerosene oil). The details of this treatment are given in another issue of this *Journal*.

Fumigation with petroleum may be undertaken if facilities for it are available where stocks of grains are found badly infested. In recent experiments conducted here, the possibilities of this fumigant in this direction were worked out on a small scale; more information on this subject is found elsewhere in this *Journal*.

8. Summary

(1) The methods of storage of grains commonly practised by ryots and the experiments and observations conducted on the subject are briefly described and the defects inherent in the methods noted.

(2) The advantages of "Sand treatment" (having a layer of fine sand, two to four inches thick, spread on top of the grain) are discussed.

(3) Spraying an extract of pyrethrum in kerosene oil on gunny bags stored with grains is indicated.

(4) Fumigation with petroleum of badly infested stocks, wherever feasible, is suggested.

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Ergot on Sugarcane

By S. V. Venkatarayan,

In November 1943 a number of arrows of the sugarcane variety CO 419 were seen to have failed to set seed. Examination showed that the kernels in a few florets had been replaced by sclerotia. These are the compacted vegetative bodies of the fungus looking like seeds and known as ergot. Ergot has been known to cause a blasting of the kernels and emptiness of the florets, besides replacing the kernels of infected florets by the sclerotia. The infection was first noticed on the Hebbal Farm and subsequently on the Irvin Canal Farm, Mandya, the Ramakrishnapur Farm near Anekal and at Bidadi. It probably occurs wherever seedling canes are grown in Mysore.

Ergot on sugarcane in Mysore has been reported by Thirumalachar,[3] the only other reference to this fungus being by Ocfemia[2] in the Philippines. Ocfemia states that it is a species of *Claviceps* probably *Claviceps purpurea* (Fr.) Tul. Only the ergot stage has been noticed so far in Mysore. The ergot or sclerotial stage of *Claviceps purpurea* was at one time given the distinct name of *Sclerotium clavus* DC. The fungus Claviceps is unrepresented in India. Butler and Bisby[1] state that the genus Claviceps is represented only by Sphacelia stages which are usually precluded from continued development by attacks of Cerebella. Sphacelia occurs commonly on jola, *Andropogon sorghum*, on which it causes the common *joni roga*. Incidentally, sugarcane belongs to the same tribe or sub-family of grasses as jola. The occurrence of the ergot on sugarcane takes the course of development of the fungus one stage further. It is probably the same fungus as occurs in the Philippines. It is interesting to note that there also it occurs on arrows of the seedling cane varieties of C.A.C. 87 and P.B. 236. In Mysore it has been noticed largely on the seedling cane CO 419 and other seedling canes evolved by the Cane Breeding Station, Coimbatore, and the Hebbal and Irwin Canal Farms noted below and on P.O.J. 2725.

CO varieties—205, 213, 265, 281, 312, 313, 355, 356, 404, 408, 411, 413, 417, 418, 419, 421, 424, 428, 436, 601, 602, 603, 604, 605, 606, 607, 608.

HM varieties—658, 659, 662.

IC varieties—29, 74, 136, 137, 153.

The occurrence of ergot is important on account of the possible harm it might do to cattle feeding on infected pasture. It is quite likely that it occurs on grasses in the vicinity of cane fields from which it might have spread to sugarcane as surmised by Ocfemia.[2] The extraordinarily moist weather during the north-east monsoon of October 1943 must have favoured its spread. Ergot came to prominence in the Middle ages because of its poisonous properties to cattle and human beings, the phenomenon being known as ergotism. A wholesale epidemic of cattle in the United States at first considered to be the much-dreaded "foot-and-mouth" disease was proved to be caused by ergotised food. The ergot or sclerotia of the fungus contain several poisonous substances. Cattle feeding on infected pasture become very thin, sores are formed on the teats and mouth, the latter causing salivation. These led to the symptoms being confused with those of "foot-and-mouth" disease. The poisoned animals often become lame. In very bad cases the extremities such as the tail, hoofs, ears,

and teats may dry up and fall off. Abortion is also caused by the partaking of the sclerotia along with food. Similar symptoms show themselves in human beings also when infected rye bread is consumed.

Cases are on record of livestock having been poisoned when fed with rye screenings. A farmer in Canada lost thirty head of cattle and investigation showed that he was feeding ground screenings containing 500 grains of ergot to the gallon at the rate of two gallons per day. If these facts are borne in mind and prompt action is taken to identify fodder from suspected pasture a large amount of avoidable harm may be prevented.

The real ergot comes from infected rye, Russia and Siberia being the largest producers of commercial ergot. Besides rye, the fungus attacks wheat, barley and oats, and a number of wild and cultivated grasses and sedges. Ergot is widely used in medicine. Whether the ergot of sugarcane can also be similarly employed will depend upon the quantity that may be collected and its alkaloidal content as compared with that of the ergot on rye.

The ergot on sugarcane occurs as purely localised infections, attacking single florets. The sclerotia vary from a few to many in an arrow and are scattered throughout its length. They are never very abundant. They may be straight or curved, narrowed towards the tip to which the remnants of the ovary are attached. At the base, the glumes and palea persist along with the whorl of bristles. The bristles serve to disseminate the sclerotia like a parachute in the same manner as they help in the dispersal of the seeds. The sclerotia are hard and horny, greyish or purplish in colour outside and whitish inside. Their surface is slightly grooved, one of the grooves being prominent, giving them the appearance of date stones. The sclerotia vary in length from 2.6 mm. to 6.2 mm. and in biggest diameter from 0.7 to 1.2 mm., the average size being 4.6 mm. × 1.05 mm. In size they nearly resemble those from the grass *Molinia coerulea*, whereas the sclerotia from rye may be from 1 to 3 cm. in length and about 8 mm. in diameter. The sclerotia on sugarcane protrude sometimes only slightly from the glumes when they are inconspicuous or may protrude to about the same length as the glumes when they can be easily recognised against the sky.

On soaking the sclerotia in water, the conidia adhering to their surface float out. The conidia are colourless and almost spherical or ovoid. They occur in the honey-dew secreted by the developing sclerotium which serves to attract insects. The insects carry the conidia to other flowers and thus spread the fungus during the flowering season. In the honey-dew occur sometimes a number of other fungi, the sooty moulds. The Coniothecium stage is predominant. The sooty appearance is quite characteristic and often betrays the presence of the ergot which might otherwise have passed un-noticed. The development of the sooty mould throws the surface of the ergot into folds and in this stage it resembles in appearance the false smut on paddy caused by *Ustilaginoidea virens*.

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Mysore Ryots Must Become Machine Minded

By K. H. Srinivasan, M.A., B.Sc. (Edin.)

Politicians, economists and financiers are already busy in drawing up a programme for post-war reconstruction in India. The problems to be tackled are stupendous and manifold and embrace all activities calculated to improve the condition of our people. In an agricultural country like ours, agricultural reconstruction has a right for first consideration. The world after this war is likely to see far-reaching changes in all lands. A free trade policy or a dumping of foreign agricultural commodities into India is bound to effect the balance of agricultural economy in this country. Any inequilibrium in the cost of production and the margin of profit is sure to drive our agriculturists to the wall. To avert the catastrophe ryots should take to scientific agriculture and produce goods as cheap as possible. That is, they should produce more of saleable produce per unit of cost.

Good seeds, quick acting manure, *i.e.,* fertilisers, disease and pest control, the use of modern tillage and labour-saving appliances, all contribute their quota towards cheapening the cost of production and the increase in output. Though the use of good seeds and manure is not new to our ryot, he is yet ignorant of the role of machinery.

Very few ryots know that in Russia and Prairie lands of America and other civilised parts of the world a single individual with the help of a variety of machines can plough, cultivate, manure the land, sow seeds, harvest, thresh and bag his corn ready for quick despatch—all by mechanical implements. Though it is not desirable to eliminate man and animal-power in India to the extent done elsewhere, yet it is absolutely essential that we should introduce useful machines which can with minimum cost bring maximum returns.

Let us for instance take the tractor for ploughing. When we want to open up new land, the country wooden plough is practically useless, for it can at best only scratch the surface soil to a depth of about three inches. Iron ploughs such as Mysore pattern, Kolar Mission and Kirloskar ploughs require heavier and better-sized bullocks and even so, they cannot work the soil to the same depth of the tractor plough which can cut a clean furrow slice as big as one foot cube and completely turn it upside down. Depth of furrow and tilth are essential for deep rooting of plants and the holding of moisture in the soil, thus maintaining a better stand of crops. Further a tractor can handle from six to eight acres of land in a day whereas with a pair of ordinary bullocks we can plough an acre of land at the most. Therefore, in precarious rainfall conditions, time factor being important, the tractor becomes a very good and useful servant of man. Besides ploughing, it can be used for pumping water and working other farm machines, and also for hauling a truckful of grain to the market. Although the tractor is meant for a large unit of land, it is worthwhile to consider why a group of village panchayats should not jointly own one for the use of their members.

Another useful and simple machine is the groundnut decorticator. This can be operated by hand or other motive power. It dehusks the groundnut pods without damaging the kernels. In the present method of marketing of groundnuts, the ryot loses while the merchant beats him down saying that it contains too many empty pods; also, much material which can be used as valuable fuel for which there is so much dearth in the countryside is lost. By transporting kernels only the extra cost of transport is saved to the ryots. The cost of this machine, the decorticator, is Rs. 300, and some of our well-to-do Panchayats can own a machine for hiring out to their members.

Water-lifts, both power and bullock-driven, are very useful for irrigating garden lands. The Persian water-wheel worked by a pair of bullocks is both cheap and efficient. This or a Ramachandra improved lift is more economical and labour-saving than our *Kapile*. Power-operated centrifugal pumps are even more efficient and chep.

Consider the case of sugarcane milling by bullocks or motive power. If we compare the two, we see much inefficiency and decrease in profits in the former case. In Mysore the popular way of converting cane into jaggery is by giving contract to team workers from Channarayapatna, and its surrounding villages. Each team carries an old-fashioned mill and a pan and trucks from place to place in search of work. The mill is worked by half-starved inefficient bullocks. Nearly half the juice contained in the cane is lost in the bagasse. In the country mill the percentage of extraction varies from 47 to 52 per cent. The extraction by the power mills is from 65 to 72 per cent. Thus by entrusting jaggery-boiling to team workers our ryots are losing anywhere from 25 to 75 maunds of jaggery per acre. Besides, the process of manufacture being crude, the product lacks quality and obviously commands less price. By straining the juice frequently through a muslin cloth, removing the scum as often as necessary and adding just sufficient quantity of clarifying agents, the quality of jaggery can be much improved. The uneconomical practice of letting cane fields on contract to team workers should cease. A power-milling unit will be a blessing to a sugarcane-growing area and such a unit can be owned and worked on a co-operative basis or it may be purchased by the Village Panchayet. If desired, a centrifugal machine can be added to manufacture crystal sugar; this process was demonstrated at the Rally. Useful work in this direction has been done by some of the Village Panchayets who own iron mills and hire them out to members, but unfortunately only a few Panchayets are enterprising.

In the case of paddy hullers operated by manual labour we have two simple devices: one is a machine operated by a unit of two men and a woman, and costs about Rs. 80 (pre-war). This gives an output of six to eight pallas of paddy or three to four pallas in terms of rice per day. The advantage of this little known machine is that there is a practically no broken rice. Ryots with very limited means can own it and save a lot of money that would otherwise go to the mill. During slack seasons the ryots can with the help of this machine hull their paddy and earn an extra income.

Another simple husking device is the wooden or the stone grinding mill. This can be had in different sizes, the smaller one can be operated by a single person, while a bigger one requiring two. They can be got locally. The

inside surfaces of the two halves of the mill are groved at an angle to the central pivot and the grinding stone can be easily operated by persons squatting on the ground. The out-turn of the small wooden mill exhibited at the Rally is about one to one and half pallas per day; but the resulting rice is practically unpolished. That is the defect in both the contrivances; bran is not obtainable unless rice is again polished by hand-pounding. The advantage of these simple devices is to be looked elsewhere. The rice mills charge twelve annas for milling a palla of paddy. In the case of the machine huller we have demonstrated that the unit of labour employed can earn Rs. 4-8-0 to Rs. 6-0-0 per day, and in the case of the hand-mill the labour earned is from 12 annas to Re. 1-2-0. Thus in both cases the wages amount to about Re. 1 a day per person. It appears as though we have not been curious to see the working of such labour-saving machine. The village folk are rather content to produce a bumper harvest; they are not bestowing attention to earn an extra income by their enterprise in marketing their goods profitably or processing their wares in an efficient manner. They can best utilise their spare time to their advantage with such simple tools.

We shall take one more instance of a small machine which can be of immense benefit to the sheep-breeders. At present sheep shearing is done by professional men who go from village to village. The day's clip of wool is taken by the man, who gives a *kambli* (blanket) costing about Rs. 1-8-9 to Rs. 2-0-0 to the owner of the flock. The clipper gets the benefit of the full value of the fleece, say Rs. 8 from a flock of 25 sheep. The clipping operation is very simple and any one of the enterprising and intelligent youngsters of the village can be trained to this work. There is a simple wool clipping machine (shearing machine) which is hand-operated. This does decidedly more efficient work than the country tool; 120 sheep can be clipped in a day with this clipper as against 30 sheep by a hand-clipper. The cost of the shearing machine is about Rs. 125 and its working parts are so simple that nothing can go wrong with it. Such a clipping machine is a valuable asset to the sheep-breeder. It is desirable to encourage each Village Panchayet to maintain one such machine for the use of its members.

These are some of the important machines whose working and usefulness were demonstrated at the "Gramasudharakas'" Rally at Hassan. There are indeed many other machines which are useful to the agriculturists. We are living in an era of machines and science is aiding man ever more to harness the machines to his advantage. Unless our Mysore ryot changes his mental outlook and invokes the blessings of scientific agriculture he cannot be an asset to the society of which he is a member, himself being strong in the body and having his hunger satisfied. He must shake off his apathy and conservatism and seek the path of progress; or else he will continue to be poor and miserable. The Mysore ryots should awake to the usefulness of the 'Machine' as their willing servant.

Some Impressions of a Tour To and From Baroda

By B. V. Venkatacharya, B.Sc.Ag.

(*Inamdar, Alakere, Mandya Taluk*)

I was deputed by the Government of Mysore, as a non-official representative, to attend the Fifth Meeting of Crops and Soils Wing of the Board of Agriculture and Animal Husbandry in India, held at Baroda from the 22nd to 27th of November 1943. I took the opportunity and visited North Gujarat--Mehsana and neighbourhood, the Poona Agricultural College and the Sugarcane Research Station, Padagaon, in Bombay (Deccan), while returning from the meeting. I wish to note here some points of agricultural interest that I observed during my visits.

The Museum at the Baroda Agricultural Institute

All the representatives of the various Provinces and States assembled at the meeting at Baroda took keen interest in the study of the Museum got up by the Agricultural Institute. We were delighted to see working models of engines, agricultural machinery, of soil types, of crops, cattle, sheep and poultry, beautiful in colour and life-like in character. The entire work of the Agricultural Department of the State is discussed in the language of the eye. The existing variety of practice is compared with the improved type over well-designed models; and the nature and quantum of improvement or increase over the local method is told by ocular demonstration in a reasonably concise and clear form—a quick and appealing method of propaganda.

To describe a model in a case about "soil erosion": Depicting, in natural colours, a portion of a landscape is shown to have been much scoured away by sheet erosion, and has developed deep ravines and a lot of undulating surface. The attempt at growing crops on the patches of level land results in scanty growth. There is no outlet for the flood water and no efforts at bunding to check erosion. In striking contrast and quite abutting this picture, there is another model where science and research have come to the rescue of man. The same background and piece of landscape is preserved, the devastating water-course is deviated, graded and canalized, the land eased out, reclaimed and contour strips are introduced. The toy crops raised on the strips bear ample testimony to the efficiency of the soil conservation service rendered by the agricultural department. The arable area is increased manifold and the cultivable waste is reduced to almost nil. Both the models together occupy an area of 25 to 30 square feet and are kept in glass cases to preserve their colour and prevent the deposit of dust. Hanging from a ring outside the case, there is a pamphlet, describing in pertinent detail, the Department's work on "Erosion control", at the same time offering an intelligent guide to the model.

I remember another set of models on "Consolidation of Holdings". A portion of a village and its lands under existing conditions of scattered holdings, odd pieces and fragments, owning a large number of bullock pairs, is compared with a well-planned countryside with fewer bunds, lesser cattle for the same area to work the ploughs and the rise in cultivated area.

We were informed that this Museum is the result of two years of strenuous work by Mr. R. G. Allen, C.I.E., the Commissioner of Agriculture, Baroda State, and his wife. Most of the models were made at the Commissioner's bungalow

from cheap materials. A few of them were prepared by Vasant Model Works, Poona City. The Government of Baroda have given a liberal grant for the establishment of the Museum. The Museum itself is unique in India and is adapted from the Budapest (of Hungary) Agricultural Museum, the only one of its kind in Europe and the East. In the words of a leaflet published by the Agricultural Institute, giving "an outline of principal exhibits and how to see them": "There is enough in the Museum, in as far as possible, shown in model or distinctive colours, to provide a student with a number of hours of concentrated study, which if he does it with care, will leave him fully grounded in the essentials of modern agriculture and its allied subjects."

An Agricultural Exhibition

The Department of Agriculture had arranged an Exhibition at the Central Farm at Baroda. Apart from the varieties of crops or manures, I was attracted by the method of the arrangement of the exhibits. The show was dissected into its district components, one full stall being occupied by each of the four districts forming the State. Large maps of the particular district were hung in each stall, wherein were shown, with colour beads, the position of the Research Stations or Farms, the villages where intensive propaganda is carried out, the location of demonstration, the subvention and the seed-farms, etc. By the side of these maps, there was a chart to show the total area under cultivation in the district the areas under principal crops compared with the annual progress made after the introduction of improved strains, the progress of the demonstration, the subvention and seed-farms year to year and in a general way what the Agricultural Department has achieved during the years under review. The exhibits included the types of soil in the tract or district and possibilities of improvement of the local crops or the introduction of new ones to suit the types of soil and climate. The insects and pests affecting the crops in the district were next shown, and also the methods to combat them. Each unit was self-contained for purposes of agricultural propaganda and was in charge of the Inspector of Agriculture of the particular district, who explained the maps, charts, the other exhibits, etc., with the intimacy of the tract and its possibilities.

Conditioning of Cured Leaf Tobacco

Another detail which interested me was the method of conditioning of tobacco leaves after flue-curing. Cigarette tobacco growing is a new venture in Baroda. Due to heavy rains, the planting of tobacco has got to be done during the same month every year which would eventually yield leaf in a season when there was low atmospheric humidity. Therefore conditioning of cured leaf becomes a constant problem; this is achieved on the Central Farm by recharging the leaf into an underground cellar, specially built for the purpose, having the same cubical contents as the barn and being situated just beneath the barn itself. Because of its location, the humidity in the cellar is high and is able to bring the leaf into condition for further handling.

Agricultural Oddities in Mehsana District

From Baroda I went to Mehsana, the headquarters of a Northern district of the State with the same name and about 100 miles from Baroda. Before

reaching Mehsana, we pass two places of agricultural-industrial importance: the one is Anand, the place where Polson's Butter takes origin, and the other is Ahmedabad, the Lancashire of the East. On the banks of the river adjoining Ahmedabad is located the Sabarmati Ashram.

Mehsana district has a sandy alluvial soil and the chief crops are jola, thogari, cotton, rape* and castor. The district has also mhote wells and wheat, cumin,* isaphgul,* tobacco and rajgira* are raised under irrigation. Due to condition of rainfall, weather and soil, the ryots have evolved a method of mixed cropping in the tract: Sajje and thogari, jola and cowpea or avare, jola rape, cotton, gingelly sown with castor. Castor occupies a great place in the rural economy of the district and one of the biggest areas for castor production in India is found in Mehsana.

I observed that the castor type grown here is peculiar in this way. The pods in the bunch do not burst when ripe and, therefore, the ryot allows all the bunches to ripen and makes a harvest with only one picking and transfers the bunches direct to the thrashing floor for separating the seed. Here in Mysore the seeds in the pods burst out as soon as a bunch gets ripe; thus the Mysore type does not allow the bunches to be harvested all at one time. Therefore, the picking of bunches is done once in four or five days as soon as one pod in a bunch begins to dehisce and the day's harvest is collected in a gunny or in a closed earthen pot for fermenting for two to three days, after which the bunches are given a slow-drying and then preserved until the completion of the harvest. Finally, the pods are taken over to the thrashing floor.

The Mehsana cotton also behaves similarly: the bolls do not open and, therefore, the seed-cotton is not exposed when ripe. The bolls remain "mum" and closed. The bolls are picked only once and when all of them ripen, collected in the houses and the seed-cotton is separated by the womenfolk at their leisure.

These varieties of cotton and castor save labour and save time.

In garden lands I found a strange vegetable. It grows like radish (ಮೂಲಂಗಿ) but, instead of giving roots, it throws out a big flowerhead producing innumerable pink-coloured, long, slender pods with a good flavour and taste. Its Gujarati name is Mugri (ಮುಗ್ರಿ).

The buffaloes of Mehsana deserve special mention. The Northern Indians are a set of business people and they have developed the art even in buffalo trade. The milking buffaloes are priced at "so many rupees per seer of milk yield"! The type itself is a compact one, not so huge and cumbersome as the Murrah or the Delhi type. It is for this reason that very many buffaloes maintained in Bombay and its suburbs are purchased from this region. They occupy less space, consume less feed, but give more milk proportionately! I feel that we should import the Mehsana breed for grading up of the local stock of buffaloes in Mysore, because it comes nearer to our local type than the Murrah and satisfies our requirements.

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* Rape (*Brassica campestris*), ಎಣ್ಣೆತೆಗೆಯುವ ಸಾಸಿವೆ.
Cumin (*Cuminum cyminum*), ಜೀರಿಗೆ.
Isaphgul, ಇಸಂಗೋಲಿ ಬೀಜ.
Rajgira (*Amaranthus campanulatus*), ರಾಜ್ಗಿ.

A Few Suggestions for the Improvement of Fisheries and Fish Industry in Mysore State

By B. S. Bhimachar

Scope for Fishery Development in the State

It is well known that fish is rich in nutritive value. It contains a high percentage of protein, fat, mineral salts, in addition to a good amount of vitamins which is considered to be indispensable for a balanced diet. Further it has been determined that these substances are easily and almost completely digested. Fish, therefore, forms an important item of the food of the people in practically all the advanced countries of the world.

In India, however, the value of fish has not been realised. Even the educated classes have not paid much attention to proper dietetics. The adoption of a balanced diet in India is of utmost importance since it is the foundation of public health. There are immense fishery resources in India but unfortunately they have not been developed. The fishing industry is in a backward condition. The Royal Commission on Agriculture in India have rightly observed, "We have been greatly struck with the comparative failure to develop the fisheries of the country. ..... The addition of the fish to the diet of the cultivator seems to be the most promising way of securing that improvement in his nutrition which is so much needed and all measures practicable to this end should be taken."

It is to provide this much-needed nutritive food to the people that our Government has taken steps to develop the fisheries of the State. There are vast fishery resources and nearly 80 per cent. of the population of the State eat fish provided it is available. Efforts are being made to develop the fisheries of the rivers and tanks by effective conservation and by the introduction of certain important food fishes from outside the State. This work is proposed to be started in certain selected areas of the State at present. Till such time as the work is extended to the whole State a few useful suggestions for improving the fisheries of the tanks, growing fishes in paddy fields and proper drying of fishes for the benefit of those engaged in fishing, are given below.

Suggestions for the Improvement of Tank Fisheries

Preparing a tank for growing fish.—Just as the cultivation of land is needed for growing crops, it is necessary to prepare a tank for growing fishes. Such a step is not being taken at present and hence the tank fishery is very poor. There are several factors affecting the life and growth of fish in a tank.

The water in the tank should be clear and rich in oxygen content. It is seen that in tanks in which water is reddish on account of suspended sediment the fishes do not thrive well. The suspended mud in water interferes with the respiration of fishes. Such tanks are mostly devoid of vegetation. It is further observed that in tanks where there is good growth of aquatic vegetation the water is clear. The aquatic plants liberate good quantity of oxygen and, there-

fore, the water is rich in oxygen content. If any tank is devoid of such plants, they may be collected from the neighbouring tanks and introduced into it.

Aquatic plants like pond lily (Nymphæ), Eel grass (Vallisnaria), Musk grass (Chara), water weed (Elodea), Bladderwort (Utricularia), Duck weeds (Lemna), hairweed (Spirogyra) and a few others form the food of fishes. It would be necessary to introduce them in tanks where they are absent. Certain species of fishes feed largely on aquatic insects, molluscs, worms and other animals. The aquatic fauna thrive very well in tanks where there is a desirable quantity of vegetation. The vegetation in water gives shelter to fishes and their fry. While the aquatic plants are so essential as food of fishes, to give them necessary shelter, to stimulate the growth of aquatic organisms, to keep the water clear and oxygenated, any excessive growth of vegetation is detrimental to fishes. The excess vegetation should be removed and it would form excellent manure for agricultural purposes. Any decaying organic matter in water should be removed since it is harmful to fish life. The ground at the bottom of the tank should be hard and free from silt and organic debris. It is good to dry the tank-bed occasionally, plough it and a short-season crop grown there which will render it fertile. Occasional manuring of the tank-bed is also desirable.

Affording facilities for migration.—It is well known that our tanks are constructed across the drainages and sub-drainages of the rivers. During rains the tanks get filled up and overflow into the tanks in the lower reaches and finally into one of the rivers. Thus a regular water connection is established between the various tanks in any particular drainage. The fishes have a tendency to migrate upstream. During rains the fishes from the rivers and perennial tanks below migrate to tanks in the upper reaches. It is by such a migration that the tanks get stocked with fishes. This is a natural method of stocking in our tanks. The water connection between the tanks and rivers is present just for a few days in the year. The fishermen seem to know this habit of the fish very well and they fix basket traps across such waters and catch all the migrating fish among which there will be both breeding fish as well as their young ones. It is by this way the tanks which would have normally become rich fisheries have been depleted. It is, therefore, very necessary that such an interference with the migration of fishes should be prohibited if our tank fisheries are to be enriched.

Another obstruction to the migrating fishes noticed is the height at which the water drops at the wasteweir which in the case of certain tanks is unsurmountable by fishes. To facilitate easy migration of fishes it is necessary to give a gradual slope or build a fish ladder along the wasteweir. In case of tanks where such an arrangement exists as in Ramasagara tank and Sulekere the fishery has been noticed to be rich.

Providing protection to the breeding fish and their young ones.—The fishes breed during the rainy season. The breeding fish come to the shallower parts of the tanks and the creeks along the rivers for breeding. The fishermen know this habit very well and catch them in large numbers. Further it is noticed that the early growth of the fry takes place in the shallow water along the margin of the tanks and they are easily caught in large numbers with prawn nets. If the breeders are allowed to spawn and the young ones to grow, the fishery

would become immensely rich. Similarly large quantities of very young prawns are caught and dried in sun. Such sun-dried young prawns can be seen sold in shandies. It is, therefore, necessary to prohibit such destructive fishing. To enforce such a step, the period when the fish breeds has to be declared closed for fishing. Having enforced this, judicious fishing should be done during the rest of the year.

Species of fish in our tanks.—The common fishes of our tanks are:—Murrels (ಕುಚ್ಚು, ಕೊರವ, ಹೂಮೀನು, ಹೊಲಗೊರವ), Catfishes (ಆನೆ ಮೀನು, ಚೇಳು ಮೀನು, ಗೊದ್ಲೆ (ದೊಮ್ಮೆ), ಗಿರ್ಲು) and Carps (ಗೆಂಡೆ, ಪಕ್ಕೆ, ಅರ್ಜ, ಸೊಸಲು). All these fishes are tasty and highly nutritious. These fishes are not uniformly distributed in all the tanks. If any of these are absent in a perennial tank they can easily be introduced by the local people. The young ones of the species required can be collected from any of the neighbouring tanks, carried in water in an earthen pot and let into the tank. The local species are not well suited for large-scale production of fishes and, therefore, the Department of Fisheries is making efforts to import into the State certain species of big-sized food fishes from the rivers in Northern India and when they are available for stocking, steps will be taken to eliminate some of the predacious species among local fishes.

Growing Fish in Paddy Fields

It is well known that when water is let into the paddy fields certain species of fishes from the channels enter the paddy fields. After some time the fishes migrate against the current back to the channel. The fishes are either caught in the paddy field or when they ascend the channels in basket traps. If, instead of catching them when they are young, as is done now, they are allowed to grow in the paddy field the agriculturist can reap a good harvest of fish along with paddy. The water in the paddy field is rich in fish food which accelerates the growth of fish. Further the fishes devour the parasites that may affect the paddy crop. The paddy fields in Mysore State are not so well suited for this purpose as those in Bengal and Travancore where rearing of fishes in paddy fields is extensively practised. The bunds of the fields have to be raised to allow a greater volume of water to stand there for rearing fishes. Bamboo grates have to be fixed both at the inlet and outlet so as to confine fishes to the paddy field. When the water in the field becomes fairly clear it can further be stocked with fishes that may be caught in basket traps in the neighbouring areas.

Dry Fish and Prawn

The smaller species of fishes and the young ones of bigger species and prawns are caught in large numbers both by nets and in basket traps all over the State and are dried in the sun. They are sold practically in all shandies as 'Karimeenu'. It is noticed that the guts are not removed before drying the fish and the consumption of such fish often causes diarrhœa and other digestive ailments. In the interest of public health it is necessary to press out the guts from the fish. A really wholesome product can be obtained if such fish from which guts have been removed are cleaned in brine and then dried in the sun.

It is noticed that during summer when the water is very low in the tanks fishing is done by a general battue just for a few days and fish are caught in some places far in excess of the local demand. They are generally not transported to bigger markets. Whenever large number of fishes are netted the bigger fishes can be gutted and sliced. The fish slice soaked in brine and dried in sun will preserve well and form good eating. The head and other parts which form waste in this method can be dried, powdered and the fish-meal thus derived is good for feeding poultry and cattle.

Fish diseases.—Whenever mortality of fishes due to heavy infection of parasites and other diseases is noticed the matter may be reported to the Fisheries Officer, Department of Agriculture, Bangalore, to enable him to take necessary action.

Dry Cows, Their Care and Management

By G. Gopinath, B.A., C.D.D. (Glass.), N.D.D. (Scott.)

The period of dryness, that is, the non-milking days in a cow, varies considerably, especially in India. It extends from two months to five, and in many cases even up to eight months; the average being about four months. Instances are not far lacking where cows have given milk up to a few days prior to calving. The importance of such good cows needs no exaggeration, especially in a country like ours where dairying is still in its infancy. The efficiencies of such good cows are carelessly utilised by our common *gowallas* and ignorant ryots, whereby they lose their capacity to produce which ultimately impairs production. "A highly improved breed deteriorates much sooner when neglected or managed ignorantly than a breed that has undergone little or no improvement. They cannot do well if managed under primitive methods. To be profitable the herd must be well looked after." With such cows having a long period of lactations, care must be taken to dry them off so as to give them a period of just at least for six to eight weeks, prior to calving again. This will enable the cow to get back the strength to stand the strain of calving which very much has a bearing on her future milk-production. On the contrary to these types, we get a high percentage of cows which go dry very soon. It is not uncommon to see cows going dry within a period of two to three months. Keeping such cows, though they may be pedigree ones, is hardly worth the labour of a dairyman, and they are only a liability rather than an asset to any farm. Animals of this type should be culled off from the herd and good ones replaced in their places to safeguard the production level of the farm and thereby on its returns.

Such is the variation we find among our dairy cattle wealth of India. It is for the purpose of combating this tremendous variations that many institutions and dairies adopt the system known as "Milk recording". By a good knowledge of animal husbandry coupled with systematised milk records a dairyman can improve his stock to his own advantage especially with regard to the upkeep of dry cows. He will be in a better position to select which to keep and which to sell off among his dry stock. He will soon learn that keeping a good cow that has gone dry for a short time is a profitable thing than to sell it off and replace another in its place at a high cost. By a judicious knowledge of his own stock by records, he will be able to adjust his total strength in such a way to ensure a level flow of milk from his farm all the year round; which automatically earns the goodwill of his customers. This sort of system is the keynote in dairy farming among European countries; by which 80 per cent. of the farms are able to keep up a level production and the rest aim at a high production during summer months, since there is a greater demand for milk. How many of our good cows go to the butchers just because they are dry; and because their owners are ignorant of this fact. The extract below taken from

Cow Keeping in India will prove the importance of keeping a good dry cow. The example here is just to show the usefulness of keeping a dry cow and it should not be taken as an ideal especially at the present time. The calculations were made during pre-war days.

Dr.	*Rupees*
Purchase of a cow giving about 12 lbs. of milk daily	240
Cost of food, upkeep, etc.	250
TOTAL ..	490

Cr.	*Rupees*
Value of milk at 8 lbs. per Rupee for 300 days ..	450
Value of calf at 10 months	40
Sale of cow to butcher	60
TOTAL ..	550
EXPENDITURE	490
PROFIT ..	60

If kept till next calving:

Dr.	*Rupees*
Purchase of cow	240
Cost of food, etc., for 10 months	250
Extra cost for 4 months when dry	32
TOTAL ..	522

Cr.	*Rupees*
Value of milk	450
Value of calf	40
Value of cow when she calves again	240
TOTAL ..	730
EXPENDITURE	522
PROFIT ..	208

So we see that to keep a good yielding cow the second year will yield more than three times the profit that she yields if kept only one year. Of course, this presupposes proper management.

The common belief that keeping a dry cow in calf is great trouble and extra expense is not true unless a cow is an inferior one or has been spoiled or has become barren due to some disease. As has been pointed a good cow will amply repay her owner if kept till she calves again. The cost of keeping

a dry cow until she calves will not exceed the difference in price between a dry one and one in full milk. So by selling away a good cow just because she has gone dry is the most foolish thing a good dairy farmer can do to himself.

Care and Management of Pregnant Animals

The usual practice that is common in our country is to give away the cow to a paid man to look after it and allow it to graze till she calves. No care is taken to see about their management, their feeds and health. Usually there will be a large number of cows under one man's care and it will be impossible for him to pay individual attention to each cow. He will drive the whole lot as his fancy takes him and they are supposed to graze while he will sleep under a tree. In the evening they are brought home and tied up; and his routine job is finished. Many a man has paid a lot through this carelessness and in spite of it all this system is going on as usual. If only people take an interest in farming "Dry Cattle Farms" or send their cattle to well-established and already existing farms, how well can we improve the dairy cattle wealth of our country! A good cow should give milk up to about three months before she calves again. Some cows give full milk until they are four or five months in calf again, some lessen their milk soon after becoming pregnant. The average period when a cow begins to drop her yield is about six months from the birth of her calf. As the months go the yield is less and less and finally it has to be dried off. As the yield becomes less and less the feed also should be reduced in proportion and a "spare diet" reached when it is fully dry. Some people with the belief that they will get more milk begin to feed their dry cattle lavishly with all sorts of rich food. This is not only a waste but also a dangerous step to take. The rich food will make her only to put on fat and lose the confirmation of a dairy cow. Rich food makes her to go into heat in spite of pregnancy, which if served will impair the growth of the fœtus. It will also make the cow to throw off the calf. The ration for a dry cow should be just enough for her maintenance plus a little allowance for the development of fœtus. Rich food like oilcakes, cotton-seeds, etc., and others which tend to fatten her must be avoided; and if at all it is included it must be just the amount required for her maintenance. Overfeeding runs into fat and once the cow begins to do this, it will be a hard job to check it even when she starts giving milk. She will be fit only for the butcher. A dry cow should have plenty of grazing and where this is not available, cut grass should be given. Good quality straw should form bulk of her food where grass is not available. Straw may be given at night along with two pounds of bran and one pound of ground gram along with an ounce of mineral or an ounce of salt for the animal to munch at night. If there is no green grass at all in the ration the bran and gram could be raised by two pounds and half a pound per day per animal of average size and average yields. A simpler method of rationing that has been adopted in some private farms in India is to give the dry cow one-fourth the quantity of concentrates of the milking cow, the straw and grass remaining the same. This, it seems, has given good results. Whatever the rations might be all we have to remember is to give a dry cow sufficient nutrients to maintain herself in good condition prior to calving. They should not be over-fed nor should they be given any rich food. The food should also be laxative in nature.

Cows that are in calf must not be kept tied up all day. They should be allowed to walk and graze as they please. If this is not practicable they could be tied up in some open place with ropes at least forty feet long. Good exercise is absolutely necessary for in-calf cows; otherwise they will sucer during delivery time. Great care is absolutely necessary to prevent any disease to affect their health and they should all be kept far away from cows that have had abortions. Young bulls and barren cows and also cows that are in heat will worry the in-calf cows and injure them. This should not be allowed. The cow should be in a good health to stand up to the strain of parturition.

Care at Delivery Time

The approach of the day of parturition is shown by the enlargement of udder and the mammary glands becoming active. In heavy milkers it might swell up to such an extent that it may be necessary to start milking a couple of days before the calf is born. The milk vein also becomes distended and prominent. As the delivery time draws near the skin of the vulva becomes loose. There can also be seen a slight depression in the lumbar region. The animal tries to go to a quiet place often and is restless. It tries to sit down and get up often and often and tries to deliver. The genital opening widens and the fœtal covering protrudes out, and bursts. Then we see in normal conditions the two front legs coming out followed by the head. If anything abnormal is seen veterinary aid should be sent for at once, if not, at least an experienced milkman should be brought in. A couple of hours after the calf is born the cow should be given a warm refreshing mash prepared by boiling in water either crushed wheat, barley, bajra or bran to which a little jaggery, pepper and salt are added. This not only refreshes the animal but also acts as a stimulant in getting rid of the "after-birth". Such a mash should be given preferably twice a day for about three days, and a warm mash without the condiments for about ten days, after which a regular balanced ration can be adopted. The after-birth which normally drops out in about three hours time, if it takes long, being embedded in cotyledons, should be carefully removed with the help of a veterinary surgeon or otherwise it will cause blood-poisoning. After delivery the cow should be cleaned with a moist cloth dipped frequently in hot water and then she should be taken to a dry place. Exposure to adverse climate should be avoided. The cow generally cleans the body of the calf by licking but we should see that its eyes, ears and nostrils are cleaned and freely working. If any sticky matter adheres it should be cleaned. If there is too much bleeding from the navel cord it should be stopped by ligature. The cow should not be excited in any way or otherwise it will become vicious during milking. Do not give much colostrum to the calf in the beginning.

Results of Certain Experiments and Observations Carried Out Recently in the Matter of Control of Insect Pests of Food Grains in Storage

By

B. Krishnamurthy, B.Sc., F.R.E.S.

and

D. Seshagiri Rao, B.Sc.

1. Introduction

The data presented here are the outcome of certain experimental work in connection with the control of insect pests infesting stored food grains undertaken recently in the Entomological Section of the Mysore Agricultural Department. A comprehensive scheme of experiments and observations relating to this important problem has been planned and initiated; but as some of the results obtained in the course of the work have been found to be very significant it was considered advisable to publish them immediately. Further instalments would be published as and when sufficient data accumulate.

In this paper the effect of mixing various easily available insecticidal and inert substances, in small quantities with stored grains is mainly described and discussed. Although the experiments have been so laid out as to yield data concerning the effect of these substances on the concerned insects and food grains in storage over several months, yet certain encouraging trends with some substances have been noticed within short periods of exposure of a couple of weeks or even a few days. Also, some interesting differences are seen between really small scale trials as in Petrie dishes compared to bigger receptacles like glass jars and miniature gunny bags.

These experiments and observations were mostly made during March-April, 1944. As the receptacles employed (except Petrie dishes) were easily accessible for the free circulation of air in them, there could really be no essential difference between the inside temperature and relative humidity of the receptacles, and these same physical factors in the interior of the laboratory. It may therefore be considered that this work was carried out under normal room temperature and relative humidity conditions. The prevailing conditions inside the several lots of grains were probably slightly different but they were not considered to be of sufficient practical importance for the purpose of this work.

2. The Receptacle

The receptacles employed in these experiments were Petrie dishes, glass jars, small gunny bags holding one seer of grain, small earthen pots with covers plastered and small bamboo bins variously plastered over. In Petrie dishes with tight-fitting covers, though the quantity of grain was naturally far in excess of

the requirement of the insects confined within, higher rates of mortality were noticed in a shorter time than other receptacles; this is probably natural enough in view of the quicker vitiation of the air in the very limited volume of space within; in other receptacles, like, for example, gunny bags having scope for free circulation of air, lower rates of mortality were obtained for the same periods of exposure.

3. The Use of Certain Inert Substances

Road dust (fine), wood ashes, lime powder, kaolin, coal ash (fine) and paddy husk and its ash (powdered and not powdered) were tested, mixed with grains in different proportions and their effect on the insects noted. Road dust in fine form produced by sieving through a double layer of close mesh cloth (but not ground to finer size) is found ineffective, neither having deterrent properties nor killing insects in the grain mixed with it, presumably because the individual particles are not fine enough to adhere to the grains and, therefore, except for a non-adherent thin film on them, the rest of the dust accumulates at the bottom; probably with continued grinding as described by Briscoe[1] the particles are rendered fine enough to adhere readily to the grains, but in large scale work this may not be advisable, as there is danger of "Silicosis" to workers.[1]

Wood ashes, lime powder and kaolin in a fine state, adhere to the grains easily; they appear to have a certain deterrent value, but their comparative effect requires to be worked out by further trials. Regarding mortality of insects (weevils and Bruchids) in these media, lime powder and wood ashes are round about the level of the control only while kaolin is better, though greatly inferior to coal ash (fine) and paddy husk ash (fine) as may be judged from the accompanying table.

Coal ash in extremely fine form with the particles varying in size from 4 to 15 microns obtained by continuous grinding in a laboratory agate pestle and mortar as described by Briscoe[1] appears to act very effectively both as a deterrent and an insecticide to adult insects (weevils and Bruchids) inside the medium. The insects get a thick coating of the black powder all over their bodies and are somewhat sticky to touch. In doses of 1 per cent. of the weight of the grain, coal ash (fine) appears to suffice for yielding the desired results; as owing to its fineness, the grains get a uniform coating of the powder easily, turning pale blue-green like raw coffee seeds in the process. A short exposure of only three days is found to be enough for the bulk of adult insects within the material to be killed.

Mr. M. J. Narasimhan, the Director of Agriculture in Mysore, in the course of his recent tour in Kadur District, found that paddy husk was in somewhat common use among certain agriculturists for storage of Bengal gram. With a view to testing the efficacy of paddy husk as an inert substance for mixture with stored food grains, in the work of control of insect pests, the material—both raw and burnt—in coarse as well as fine condition was employed for a series of trials.

Paddy husk ash in finely powdered form (ground with mortar and pestle for a few minutes and not subjected to continuous grinding, as in the case of coal ash) approaches, coal ash powder in its efficacy in killing insects present in the grain mixed with it. (Its deterrent properties have not been investigated

yet). The grain takes on a pale blue-green colour and the insects are coated with the black powder in the same way as with coal ash; mortality of adult stages of insects, in the medium occurs, after a short exposure of three days with the use of a 1 per cent. mixture of paddy husk ash in much the same way as with coal ash, and probably the mode of action of both is identical. It may be stated here that the results obtained and recorded with reference to paddy husk ash were with particular reference to work on Pulse Bruchids and that trials with other insects (weevils and beetles) have been started and the results will be published in due course.

Examined microscopically, the particles of paddy husk ash in the form in which it was used, are found to measure 4.5 to 13.5 microns in size (though both bigger and smaller sizes with in this range were also present). Particles of these sizes have an indented and sharp outline; and particles smaller than 4.5 microns in size appear rounded in outline with no sharp projections in them; presumably, therefore, grinding into an excessively fine state is not necessary in the case of paddy husk ash, as it may reduce the particles to such fine state as will deprive them of their abrasive property acting on the insect cuticle. Further trials are necessary to confirm this point. Owing to the easy availability of paddy husk in all towns and villages as well (coal ash is only available in industrial areas or along the railway) and the comparative ease with which it can be ground fine, powdered burnt paddy husk or paddy husk ash as it may be called, should be preferable to coal ash. Burnt paddy husk as such (coarse) and raw husk (powdered or otherwise) appear to be definitely less effective against the insects.

All the inert substances referred to above are easily removed from the grains with which they are mixed by washing the latter in water, a process to which grain is necessarily and commonly subjected before being cooked for consumption.

4. Work on Insecticidal Substances

Derris root powder, Mundulea stem bark powder and Pyrethrum powder used in the proportion of 3 per cent. and 2 per cent. of the weights of the grains, copper carbonate (1 per cent. by weight), sodium fluosilicate (2 per cent. by weight) and mercury (free metal) at the rate of 5 tolas per maund were mixed with the grains and their effect on the adult insects (weevils and Bruchids) after short periods of exposure were studied. Of the three vegetable insecticides Derris and Pyrethrum go together followed by Mundulea, in their deterrent and insecticidal effects on the insects. It may be stated here that Mundulea powder used in this work was nearly six years old and may have lost a considerable portion of its insecticidal value. These three insecticides incidentally, being coarse powders do not adhere well to the grains and, therefore, a good quantity of them goes to the bottom. Copper carbonate, on the other hand, being a fine powder, covers the grains closely and has good deterrent and insecticidal effect on the insects, being more or less on a par with coal ash in this respect. The insects in this medium are also similarly coated thickly with the chemical sodium fluosilicate also adheres well to the grains, but it appears to act rather slowly. In the only trial made with it in an earthen pot it gave 80.0 per cent. mortality of weevils against 31.8 per cent. in the control. Mercury has proved

ineffective against adult insects, though in one trial it has shown 150 per cent. of the rate of mortality registered in the control.

It may, therefore, be stated that Derris, Pyrethrum and Mundulea act as fair deterrents and insecticides while copper carbonate and to a lesser extent sodium fluosilicate also act against insects in the grain. Mercury is ineffective generally against adult and larval stage of the pests.

All traces of these substances mixed with the grains are easily washed away with water with no more difficulty than in preparing grains for cooking purposes.

5. Spraying Tests

Extensive trials were made to determine the effect of spraying a petrol or kerosene extract of pyrethrum in storage premises infested with different insects. The details of these trials are given in Table III. The common Lepidopterous pests like *Corcyra* and *Sitotroga* moths emerging from the superficial layers of grains, in bags and heaps, are easily kept in check by this method. Moths directly sprayed upon die immediately, but those lightly touched by the spray, keep fluttering on the ground till they die some 8 to 16 hours later. Bruchids in pulses are killed almost totally, whether stored in bags or in heaps. *Tribolium* and *Rhizopertha* beetles and Rice weevils (*Calendra oryzæ*), however, appear to be somewhat resistant. In the case of damaged stocks of jola, weevils are readily killed in large numbers by spraying whether the material is in bags or heaps. When the stock consists of sound and whole grains, spraying is less effective. Probably damaged and broken grains allow easier and better permeability of the spray through the material, than sound and whole grains. This observation needs to be confirmed by other tests.

6. Observations on Covering the Surfaces of Bamboo Bins with Different Plasters

Preliminary observations on the capacity of various protective plasters to bamboo bins to resist boring by beetles and weevils from within and without have been made. Small sample bins were got made and coated with paper mash and vegetable mucilage alone and with (*a*) coal tar emulsion (50 per cent. strength) and (*b*) asafœtida incorporated with it. Others were plastered with cowdung and red earth alone, and with (*a*) vitex (ಲಕ್ಕಿ) leaf paste, (*b*) neem leaf paste and (*c*) custard apple leaf paste. These sample bins were exposed to the action of 100 rice weevils kept confined on a small patch of the outer surface for four days. They were then examined with the results shown in Table IV. It is seen that weevils may not bore through these plasters although in each case there was grain on the other side, and weevils were themselves confined with no grains accessible to them. The bin covered with paper mash (with mucilage) only was stored with infested grain for three weeks, but with no room for the weevils to come up to the top. On examination, weevils were trying to bore their way out all over the surface. Thus if passage for the weevils (and beetles) to the top is assured, with or without a layer of fine sand as top dressing, there seems to be no possibility of their attempting to bore through the bin. Further work on these lines is in progress.

7. Acknowledgment

Our thanks are due to Messrs. M. Appanna and N. Basaviah, Assistant Entomologists, for their valuable help in making observations relating to several experiments and to the Fieldmen and Laboratoryman of the Entomological Section for their assistance in the laborious work of taking exact counts involved in the valuation of the results.

8. Summary

Certain inert and insecticidal substances in fine form were found to have considerable deterrent and lethal effect on pests of stored grains. Of these coal ash (fine) and paddy husk ash among inert materials and copper carbonate and sodium fluosilicate among insecticides take precedence over other materials tried. It seems sufficient if they are mixed with the grain in the proportion of 1 per cent. by weight of the latter. As they are easily washed away by water used for preparing the grain for cooking purposes, the question of separating them from the grain before use offers no special difficulty.

In the matter of spraying storage premises and bags of grains to prevent the spread of insects with a petrol or kerosene extract of pyrethrum, rice and paddy moths (*Sitotroga cerealella, Corcyra cephalonica*) and pulse Bruchids (*Bruchus Chinensis*) are found to be readily killed, while other beetles and weevils are affected only when directly and well hit, but weevils in infested broken jola are more readily and easily killed.

Preliminary observations made on the effect of covering surfaces of bamboo bins with protective plasters and their reaction to boring by weevils have shown that where weevils can go up to the top, as through sand, they make no attempt to bore through the bamboo bin, but if denied exit facilities at the top they are likely to attempt boring through.

A further series of trials with all the insecticidal and inert substances mentioned in this paper as used against different insect pests of different food grains has been set up and is under observation.

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TABLE I

Results of treatment of grains with certain inert materials

Receptacle	Grain, quantity and condition	Inert material mixed and its proportion	Percentage of Mortality	Remarks
1. Gunny bags ..	Rice—one seer each; free from pests	2% by weight of :		To test the deterrent effect of different substances the bags were enclosed in a cage into which a large number (750) of Rice weevils were introduced, the number actually found inside each bag being :
		Road dust (Fine)	8·0	Road dust .. 191
		Wood ashes	nil	Wood ashes .. 1
		Lime powder	6·3	Lime powder 38
		Kaolin	17·2	Kaolin .. 221
		(Control)	19·0	Control .. 169
				Examination after 3 weeks' exposure
2. Do. ..	do.	2% by weight of :		To test the actual rate of mortality in different media; bags were enclosed in jars individually with 100 weevils put into each jar. The rate of mortality recorded is after only 3 days' exposure
		Road dust (Fine)	11·0	
		Wood ashes	23·0	
		Lime powder	18·4	
		Kaolin	62·2	
		(Control)	18·2	
3. Do. ..	Jola—one seer; free from adult weevils	1% by weight of : Coal ash powder (Fine)	100·0	As in series 1, only 2 weevils inside bag. Period of exposure—3 days.
Do. ..	do.	do.	63·8	As in series 2. Period of exposure—3 days.
4. Earthen pots (with covers) plastered over	Jola—one seer; heavily infested	2% by weight of :		Examined after 3 weeks' exposure
		Kaolin	31·8	
		(Control)	53·0	
5. Do. ..	Jola—one seer; free from adult weevils	2% by weight of :		200 weevils introduced. Only 3 days' exposure
		Kaolin	51·0	
		(Control)	11·9	
6. Glass jars	Bengal gram—¼ seer; free from adult bruchids	1% by weight of :		50 bruchids (not of the same age) introduced into each jar. Examined after 3 days' exposure
		Paddy husk (powdered)	79·6	
		Paddy husk ash (Fine)	100·0	
		(Control)	74·0	

7.	Do.	Jola—one seer; free from adult weevils	Coal ash (Fine) Paddy husk (powdered) (Control)	100·0 16·3 22·4	100 weevils (not of the same age) introduced into each jar. Examined after 3 days' exposure
8.	Do.	do.	5% by weight of : Paddy husk (Coarse) Burnt paddy husk (Coarse)	 53·6 70·0	do.
9.	Petrie dishes ..	Jola—0·5 oz.; free from adult weevils. (Less than ⅓ full and loosely packed)	3% by weight of : Road dust (Fine) Wood ashes Lime powder Kaolin (Control)	 100·0 100·0 100·0 100·0 80·0	20 weevils (not of the same age) introduced into each set. Mortality figures recroded are after 3 weeks' exposure.
10.	Do. ..	Bengal gram—0·5 oz.; free from adult bruchids	3% by weight of : Road dust (Fine) Wood ashes Lime powder Kaolin (Control)	 100·0 100·0 100·0 100·0 9·00	10 bruchids (not of the same age) introduced into each set. Percentage of mortality figures refer to examination after 3 weeks' exposure. Fresh emergence recorded in Road dust, Kaolin and control, but such bruchids alive only in Road dust and control
11.	Do. ..	Jola—0·5 oz.; free from adult weevils	1% by weight of : Road dust (Fine) Wood ashes Lime powder Kaolin Coal ash Paddy husk (powdered) (Control)	 80·0 100·0 100·0 100·0 100·0 60·0 70·0	Material compactly packed and entirely filling the receptacle, 20 weevils *of the same age* introduced into each. Mortality figures relate to an exposure of 5 days
12.	Do. ..	Bengal gram—4·5 oz.; free from adult bruchids	1% by weight of : Paddy husk (powdered) Paddy husk ash (Fine) Burnt Paddy husk (Coarse) Coal ash (Fine) (Control)	 75·0 90·0 78·2 95·0 60·0	Material compactly packed and entirely filling the receptacle. 20 bruchids (not of the same age) introduced into each set. Percentage of mortality figures noted after 5 days' exposure

TABLE II

Effect of treatment of grains with certain insecticidal substances

Receptacle	Grain, quantity and conditiion	Insecticidal substances mixed and proportion	Percentage of Mortality	Remarks
1. Gunny bags ..	Rice—one seer; free from insects	2% by weight of :		To test the deterrent effect of different substances, the bags were enclosed in a cage with a large number of Rice weevils introduced into it. The number of weevils actually penetrated into each bag is as follows :
		Derris	56·2	Derris .. 16 ⎫ Examination
		Pyrethrum	41·0	Pyrethrum .. 27 ⎬ is after
		Mundulea	34·0	Mundulea .. 47 ⎪ 3 weeks'
		(Control)	19·0	Control .. 169 ⎭ exposure
2. Do. ..	do.	2% by weight of :		To study the comparative rate of mortality in the various media, each bag was enclosed in a jar into which 100 weevils were put. Examined after 3 days' exposure
		Derris	81·1	
		Pyrethrum	38·9	
		Mundulea	30·0	
		(Control)	18·2	
3. Do. ..	Jola—one seer; free from adult weevils	Enclosed free *Mercury* (1·5 gms.) in cloth bag in middle of grain	96·2	As in Series 1. No. of weevils inside bags : Mercury .. 185
		(Control)	69·0	Control .. 198
4. Do. ..	do.	do. Mercury	25·0	As in Series 2
		(Control)	20·6	
5. Do. ..	do.	1% by weight of : Copper carbonate	100·0	As in Series 1. Only 3 weevils inside bag
Do. ..	do.	do.	96·4	As in Series 2. Only 3 days' exposure
6. Earthen pots (with covers plastered over)	Jola—one seer; heavily infested	2% by weight of :		
		Derris	80·0	
		Pyrethrum	54·7	
		Sodium fluosilicate	80·0	3 weeks' exposure
		Mercury (free metal) (1·5 gms.)	26·4	
		(Control)	31·8	

7.	Do.	Jola—one seer; free from adult weevils	2% by weight of :		
			Derris	90·7	
			Pyrethrum	99·1	
			Sodium fluosilicate	92·0	200 weevils introduced. Only 3 days' exposure
			Mercury (free metal) (1·5 gms.)	31·2	
			(Control)	11·9	
8.	Petrie dishes ..	Jola—0·5 oz.; free from adult weevils	3% by weight of :		
			Derris	100·0	20 weevils (not of the same age) put into each set. Examined after 3 weeks' exposure
			Pyrethrum	100·0	
			Mundulea	95·0	
			(Control)	80·0	
9.	Do. ..	Green gram—0·5 oz.; free from adult bruchids	3% by weight of :		
			Derris	100·0	10 bruchids (not of the same age) put into each set. Examined after 3 weeks' exposure
			Pyrethrum	100·0	
			Mundulea	100·0	
			(Control)	90·0	
10.	Do. ..	Jola—5 oz.; free from adult weevils	1% by weight of :		
			Derris	100·0	Material compactly packed and entirely filling the receptacle and 20 weevils *of the same age* introduced into each. Exposure for 5 days only
			Pyrethrum	100·0	
			Mundulea	80·0	
			(Control)	70·0	
11.	Do. ..	Bengal gram—5 oz.; free from adult bruchids	1% by weight of :		
			Copper carbonate	90·0	Material compactly packed ; 20 bruchids (not of the same age) introduced. Examined after 5 days' exposure
			(Control)	60·0	

TABLE III

Results of spraying trials with Pyrethrum extract

Grain and its condition	Insects infesting it	Method of exposure to spray	Results of treatment	Remarks
1. Paddy in gunny bags ..	*Sitotroga* moths	Stacks sprayed all over	Moths issue out in numbers from spaces between bags during spraying receive the spray directly and drop down and die immediately. Others, lightly touched by the spray drop down and flutter on the ground for 8 to 16 hours and finally die. A small percentage escape the effect of spraying by flying out of its reach Ineffective on immature stages inside grains, when the paddy is directly sprayed upon	Tests conducted at the Agricultural Depot, Chintamani
2. Jola—whole grains ..	*Calandra* weevils, *Tribolium*	Heaped in culture dish	More than 75% of weevils and beetles alive and active	Examined 20 hours after spraying ; smell strong but disappearing gradually in 4 days
3. Jola—broken grains ..	Weevils	do.	Of 506 weevils in the heap 490 (96·8%) found dead	do.
4. Do. ..	do.	In gunny bag	Of 760 weevils, 750 (98·7%) dead	do.
5. Jola—whole grains ..	do.	do.	Of 960 weevils, only 50 (5·2%) dead	do.
6. Bengal gram ..	Bruchids	do.	Bruchids all dead	do.
7. Do. ..	do.	Heaped in culture dish	do.	do.
8. Do. ..	*Corcyra* moths	Enclosed in wire mesh cage	Moths violently agitated and attempting to escape through the mesh. Those directly sprayed upon die in an hour, and others just touched by the spray fall down, struggle on the ground, and die in about 12 to 16 hours	
9. Do. ..	*Corcyra* moths, weevils, *Tribolium*	do.	*Corcyra* moths dead ; weevils and *Tribolium* directly sprayed upon die but those hidden in crevices and under the bags alive and active	do.

TABLE IV

Experiments on plaster-covering for bamboo bins

Mixture employed	Insects used for testing	Effect	Remarks
1. Paper mash and mucilage only ..	100 weevils confined outside for 4 days	Weevils in grain attempting to bore through from inside. No traces of boring by weevils confined outside	Bin filled with infested Jola and exit of weevils to the top blocked for 3 weeks
2. Do. + coal tar emulsion (50% strength)	do.	No holes bored	31 weevils living 64 ,, dead
3. Paper mash + asafœtida	do.	do.	25 ,, living 67 ,, dead
4. Cow-dung and red earth	do.	2 holes found	22 ,, living 41 ,, dead
5. Cow-dung + lakki leaf paste ..	do.	No holes bored	52 ,, living 33 ,, dead
6. Cow-dung + custard apple leaf paste	do.	do.	42 ,, living 57 ,, dead
7. Cow-dung + neem leaf paste ..	do.	do.	28 ,, living 57 ,, dead

SELECTIONS

The Cattle Problem in India

By A. B. Misra, D.Sc., D.Phil. (Oxon.)

The Royal Commission on Agriculture in India of which Lord Linlithgow was the Chairman, drew our attention to the intimate relation existing between the cattle and Indian agriculture. Unlike Europe and America, where the horse (or the mule) is generally yoked to the plough, the oxen are used in India for ploughing the fields and drawing the carts. The nature of the holdings and the land tenure system do not permit of the use of mechanical appliances in tilling the soil or harvesting the crops which is done mainly by manual labour in preference to the power-driven machines. The transport of grains, foodstuffs and other commodities from the rural areas to the towns, or *vice versa*, is dependent largely upon work-cattle. Numerically India possesses the largest number of cattle heads than any other country in the world. The world's total cattle population is estimated at 690 million animals of which 152 millions are to be found in British India and 36 millions in the Indian States (152 + 36 = 188 millions). India, therefore, possesses nearly one-third of the world's total number of cattle. Soviet Union has 65 millions of cattle heads, United States 58 millions and Great Britain 7 millions only. India is not essentially a meat-eating country and the utility of the cattle, therefore, lies only in their milk productivity, or in their use as beasts of burden. The animals used for the latter purpose are almost entirely bullocks, buffaloes being employed only to a small extent in certain parts of the country. The (average) number of acres of work per work-animal in India is 5.5 as revealed by Table I.

Table I

Cultivated acres	No. of work-animals	No. of acres per work-animal
197,469,753	36,143,287	5·5

The income to India from cattle products is very great though this fact is seldom recognised by us. The value of some of the cattle products is given in Table II.

Table II

Products	Value in rupees
	crores
1. Milk and milk-products	300
2. Cattle labour	525
3. Hides and skins	40
4. Cattle manure	270
Total ..	1,135

Even neglecting the value of cow-dung as cheap fuel in the countryside and of the export trade in animals valued at 5 lacs, the value of cattle products can be safely estimated at 1,000 crores of rupees. If the value of some of the major (agricultural and industrial) products of our country were to be compared with this, then only will a correct estimate of its importance be formed by us.

TABLE III

Products	Value in rupees
	crores
1. Rice	300
2. Wheat	100
3. Sugar and *Gur*	75
4. Jute	70
5. Indian iron and steel	45

It is generally admitted that the Aryans and other immigrants into India brought their cattle herds also with them, and that the progeny of these with the endemic cattle gave rise to the bulk of our present-day stock of cattle in India. In a survey of all the existing cattle were made, it will be seen that they fall into four or five distinct categories. Several intermediate breeds or local strains will no doubt be found in which traits characteristic of one or two or more of the predominent breeds will be found to have commingled to a greater or less extent. This is due to the fact that animal husbandrying in the past has never been carried on here on scientific lines, and too often there has been free or uncontrolled breeding. To the religious minded Hindu every she-calf or heifer, good or bad, is an object of veneration, and elimination of the unfit or the undesirable among them is repugnant to his senses. Not too often the devout among them indulge in the propitious duty of dedicating bulls to the temples, which far from confining themselves to the limits of the temple rumage in the city area also without any restraint. Such acts of piety, far from doing good, are too often the cause of much deterioration in the quality of our animal stock.

At the present time, a number of distinct breeds of cows are found in India among which the following are noteworthy.

SOME IMPORTANT BREEDS OF MILK-CATTLE IN INDIA

(*a*) *Cows and Buffaloes*

Amritmahal Cattle.—One of the best-known draught breeds of India. Its home is in the Mysore State. The Amritmahals are not big animals, but rather fiery and active; and well-known for their power of endurance. This is one of the oldest of our stocks in India.

Bhagnari Cattle.—Its home is in the Bhag territory (north of Jacobabad) in Baluchistan, and in the adjoining areas of Sind which are treeless tracts where extremes of climatic conditions prevail. The cattle of this breed are well-built animals and the cows are reputed to be very fair milkers. It is a resistant breed which can tolerate heat as well as shortage of fodder. Its digestive system is adapted to accept dry fodder and the corn chaff.

Deoni Cattle.—This is found in the Nizam's Dominions. The cows are fairly good milkers and the bullocks hardy. According to some, the Deoni breed is not a pure breed because it contains lot of Gir and Dangi blood in it.

Dhanni Cattle.—These cattle are found in Attock, Rawalpindi and Jhelum areas of the Punjab and in the North-West-Frontier Province. They are moderate-sized animals but active and fast on their legs. The cows, however, are poor milkers.

Gir Cattle.—The home of these cattle is in the Gir forest of South Kathiawar. Gir cows are known to be good milkers. The bullocks are of a heavy build, but slow and lethargic in their movements.

Hariana Cattle.—Hariana cattle are bred in the Rohtak, Hissar, Karnal and the Gurgaon districts of the Punjab and in the Delhi Province.

Kangayam Cattle.—This breed is found in the south-east taluks of Coimbatore District in the Madras Presidency. These cattle conform largely to the Mysore type and make strong and active work animals, but the cows are poor-milkers.

Kankrej Cattle.—This is a highly prized breed of cattle in India. Its home is in the country lying to the south-east of the Rann of Cutch. These cattle are very extensively used in Kathiawar, Baroda and Surat for draught purposes.

Nagore Cattle.—This is a well-known breed of trotting and draught cattle in India. Its home is in the south-east portion of the Jodhpur State. The bullocks are very big animals and are prized for their fast work at the plough.

Ongole Cattle.—This breed is confined to the Madras Presidency, especially the Guntur District. The bullocks are powerful animals of a docile nature capable of doing heavy plough or cart-work, but unsuited for fast trotting.

Red Sindhi Cattle.—The home of this breed is the country around Karachi and the Las Bela area of Baluchistan. It is a small, hill-type cattle well adapted to the extremes of climate in their homeland.

Sahiwal Cattle.—This is a mixed breed arising out by selection from the local Montgomery cows with Ayreshire bulls. The Sahiwal does not make a good draught animal and generally is not a good milker, but some selected strains have done well in respect of milking yield.

Tharparker Cattle.—The Tharparker cattle are found in the semi-desert tracts of south-west Sind and the adjoining Indian States of Cutch, Jodhpur and Jasalmir. These animals are hardy and thrive on bushes, desert-grazing and residue of grain crops. This is one of the best milch breed of India and the bullocks also are good workers.

Bachaur Cattle.—The home of this breed is in Sitamarhi district. The bullocks make good work animals but milking capacity of the cows is poor.

Bargur Cattle.—Generally found in the Coimbatore District of the Madras Province. Animals are small, compactly built, fiery and difficult to curb and train as bullocks. They have sufficient power of speed and endurance.

Dangi Cattle.—Hardy cattle which can withstand the heavy rainfall of the Western Ghats. Their home is in Ahmednagar and Nasik Districts of the Bombay Province. The cow is a proper milker and the bullocks make slow draught animals.

Hissar Cattle.—The Hissar cattle is now spread over the canal-irrigated districts of Central Punjab. Animals of this breed have good stamina and can subsist on scanty food.

Kenwariya Cattle.—This breed is found in Banda District. They are small and sturdy animals. The cows are poor milkers.

Lohani Cattle.—These cattle have their home in Loralai Agency in Baluchistan and in the N.W.F. Provinces. The Lohani is a small type of cattle similar to the hill cattle in India, but make good plough and pack animals, especially in the hilly or aired tracts where they have to stand extremes of climate.

Siri Cattle.—These animals are found in the Darjeeling Hill tracts and in Sikkim and Bhutan. They possess a thick coat of hair which enables them to stand the severe cold and heavy rains. Bullocks of this breed make excellent cart animals and can pull heavy loads with ease.

(*b*) *Buffaloes*

Jaffarabadi Breed.—These are massive animals found in the Gir forest of Kathiawar. They consume a large quantity of fodder, but their milk yield is proportionately high and the butterfat content exceptionally so.

Mehsana Breed.—Murrah and Surti blood have entered into this breed. Mehsana buffaloes mature early, persist in milk and breed regularly. Their home is in the Baroda State.

Murrah Breed.—These animals are of a massive build and are found in Rohtak, Karnal, Gurgaon and Delhi. They are probably the most efficient milk and butterfat producers among Indian cattle, but are not suitable for draught work. They are used for milk and ghee production in almost all the principal cities of India.

Nagpur Breed.—These are the long-horned buffaloes of the Central and South India. They are generally used for draught work. The females are said to be fair milkers.

Kundhi Buffalo.—These large animals are found in the forests bordering the river Indus and resemble the Murrah breeds in many respects of which they may be an offshoot. The cows are good milkers.

Nili Buffalo.—These buffaloes are found in the Pakpattan Tehsil of Montgomery District and also in the Ferozepore District of the Punjab. It is a well-known breed for which a demand exists even outside the Punjab.

Ravi Buffalo.—These animals are found in the valley of the river Ravi. They have good milking qualities.

Surti Buffalo.—The best specimens of this breed are found in certain talukas in Bombay and in Baroda.

The milch animals comprise entirely of cows and buffaloes, the amount of milk produced by sheep and goats being a negligible quantity. It is found that generally buffaloes predominate in the north and the cows in the south. Taking as a whole, it may be said that 37 per cent. of the total quantity of milk produced in India is obtained from cows, 60 per cent. from buffaloes and 3 per cent. from sheep and goats.

Cows *versus* Buffaloes

Apart from the richness in butterfat content of the buffalo milk, there is a very appreciable difference in the milking capacity of the two animals. The performances of cows and buffaloes in seven representative breeding tracts in India show that, in respect of their yield, one buffalo is equal to two cows. This is borne out by the data set forth in the following table.

Table IV

	Cows	Buffaloes
1. Average milk yield per day in pounds	3·74	7·82
2. Average daily yield of milk at peak of lactation in pounds	4·87	9·92
3. Estimated average lactation yield in pounds ..	943·0	2160·4
4. Average animal production in pounds	630	1440

It will be seen from the table that the average daily milk yield of buffaloes is twice that of the cows, the respective figures being 3.74 and 7.82 lbs. per day. The average lactation yield of cows in India is 943 lbs. and that of the buffaloes 2,160 lbs. On the basis of these figures, the average daily yield of milk by a cow in India is 630/365 = 2 lbs. and that by a buffalo 1440/365 = 4 lbs.

Table V shows that the cows of Bihar and Central Provinces are poor milkers, their average milk yield per day being 2.74 and 1.67 lbs. only, and their average lactation 651.0 and 411.3 lbs. respectively.

TABLE V

Performance of Cows in Seven Representative Tracts in India

Average	Punjab		Western U.P.	Bihar	C.P.	Bombay	Madras
	Montgomery	Hariana					
Average milk yield per day	4·72	4·46	3·89	2·74	1·67	3·90	4·64
Average lactation length in months	10·43	7·62	8·25	8·14	8·94	7·90	9·54
Estimated average lactation yield in lbs. ..	1343·90	986·00	865·0	651·0	411·3	919·8	1236·4

The extent to which milk cattle are bred and taken care of depends upon the degree to which the people are devoted to agricultural pursuits as well as upon the habits of the people to consume sufficient quantity of milk, curds and ghee.

TABLE VI

Density of Cows and She-Buffaloes in British Indian Provinces

Province	Per square mile	
	No. of cows	No. of buffaloes
U.P.	60·1	42·6
Punjab	26·3	29·7
Bihar and Orissa	59·9	18·7
Madras	30·0	16·8
Bombay	23·2	14·9
N.W.F.	15·3	10·1
C.P. and Berar	31·1	8·3
Sind	16·4	7·3
Bengal	91·5	3·4
Assam	23·7	2·0

Table VII gives an index of the consumption of fluid milk, curd, butter, ghee and lassi in seven representative tracts in India. It will be seen that the consumption of milk and milk-products in Bihar and C.P. is very low.

There is a noticeable disparity between the two sexes of a given population in regard to the consumption of fluid milk. In a general way it may be said that more milk is consumed by the men-folk than by the women-folk. While milk is given freely to infants of both sexes in Indian families, more milk is consumed by the male children than by the female children between the age of 3 and 10 years or more.

TABLE VII

Consumption of Milk and Milk-Products in the Provinces

Per capita	Punjab		U.P.	Bihar	C.P.	Bombay	Madras
	Montgomery	Hariana					
1. Mean consumption in ozs. per day of milk and milk-products	15·53	12·39	9·71	5·51	6·73	12·07	6·73
2. Consumption of fluid milk in total population	6·14	6·76	6·9	4·8	2·79	5·99	1·36
3. Consumption of curd in total population	0·32	0·36	0·021	0·10	0·53	0·018	2·10
4. Consumption of butter in total population	0·671	0·363	0·054	..	..	..	..
5. Consumption of ghee in total population	0·048	0·002	0·08	0·036	0·19	0·352	0·275
6. Consumption of lassi in total population	12·61	16·8	8·2	0·6	1·3	4·05	16·9

The table given below shows that the men-folk consume more fluid milk in the Punjab, U.P., and Bihar than in the Central or South India. It also shows that the other sex consumes perceptibly less quantity of fluid milk throughout the country. Children between the age of 3 and 10 years consume, on the whole, more milk than their fathers or mothers. The infants below the age of three years seem to be equally well cared for.

TABLE VIII

Mean Consumption of Fluid Milk in Ounces

	Punjab		U.P.	Bihar	C.P.	Bombay	Madras
	Montgomery	Hariana					
1. Adults .. (over 10 years)	14·11 M 11·06 F	11·6 M 8·1 F	15·0 M 8·5 F	13·2 M 9·2 F	5·18 M. 2·90 F	8·2 M 5·4 F	8·34 M 7·40 F
2. Children .. (3 to 10 years)	10·51 M 8·67 F	6·8 M 5·6 F	10·2 M 7·1 F	11·7 M 9·0 F	5·59 M 4·53 F	7·6 M 6·7 F	11·3 M 10·4 F
3. Infants .. (below 3 years)	7·64 M 7·03 F	4·5 M 3·9 F	8·8 M 7·1 F	10·2 M 8·2 F	4·47 M 3·49 F	6·0 M 6·1 F	12·9 M 11·9 F

TABLE IX

Average Performance of Each Breed at Different Farms

Cattle breed	Number of records averaged	Average age at lactation	Average lactation in lbs.	Average lactation length in days
Tharparker				
Agricultural Sub-station, Karnal	42	3·5	4139	269
Hariana				
Government Cattle Farm, Jhansi Government Cattle Farm, Muttra Agricultural Sub-station, Karnal	87	3·3	3424	306
Sahiwal				
Government Agricultural College Dairy Farm, Cawnpore Punjab Agricultural College Dairy Farm, Lyallpur Government Experimental Farm, Ranchi Jahangirabad Cattle Farm, Multan Imperial Agricultural Research Institute, Pusa	59	2·7	5587	301
Sindhi				
Government Agricultural College Dairy, Cawnpore Agricultural College Dairy, Coimbatore Imperial Dairy Institute, Bangalore	38	3·4	3946	299
Kanderi				
Northcote Cattle Farm, Bombay	34	3·2	2938	313
Ongole				
Agricultural Research Station, Guntur	7	3·0	3216	316
Murrah				
Imperial Dairy Institute, Bangalore Government Agricultural College Dairy Farm, Cawnpore Government Cattle Farm, Jhansi	36	4·0	4491	315
Surti				
Palace Dairy, Baroda	3	2·7	3449	396

Table VII, though incomplete in many respects, because reliable data have not been available from several farm-studs and dairies for incorporation in the tables published by the Imperial Council of Agricultural Research, nevertheless, gives an idea of the average performance of at least some of our well-known breeds. The record of Sahiwal with 5,587 lbs. of milk yield during 301 days of lactation is surely satisfactory but this does not, by any means, show that the upper limit of Sahiwal's output has been reached because, in some places, nearly double this quantity of milk has been yielded by certain strains of this breed as shown below.

TABLE X

	Serial No. of the cow	No. and name of the cow	No. of lactation completed	Milk in lbs.	Days in milk
1. Punjab Agricultural College Dairy Farm, Lyallpur	SA. 6	Sardarin	4	8188	430
2. Imperial Agricultural Research Institute, New Delhi	SA. 87	Laruli	3	9138	304
3. Jehangirabad Cattle Farm, Multan District	SA. 68 SA. 76	Matki Sultani	2 2	7264 10153	355 406

It has been estimated that, on an average, 200,000 bulls are required every year for our needs, but, at present, not more than 500 are available. These 500 animals merely serve to replace the dead bulls, or those rendered unfit for work. The basic need of 200,000 pedigree bulls for improving the various strains of kine herds in the country can, therefore, never be met. The question, therefore, arises how best to meet the situation, and the only feasible alternative is to substitute approved bulls of local indigenous quality in place of the pedigree bulls. There would no doubt be no guarantee of pedigree, but what would thus be lost would be compensated for by other advantages. Pedigree bulls, for instance, are rash in temperament, difficult to handle, intolerant of heat and expensive to rear and keep in farm. Many of these disadvantages would not be present in bulls selected from the local breeds. Along with this, it would be necessary to eliminate the scrub bulls by castrating them in as large numbers as possible. This, coupled with the use of selected bulls of local strains and the elimination of the unfit, will no doubt tend to improve both the quality of the draught and the milk cattle.

A long-range policy, scientifically conceived and carefully planned, is needed for India. Haphazard breeding is not going to lead us anywhere and is fraught with danger. It should also be clearly understood that we cannot breed cattle which will serve the dual purpose of milk and traction. Actual breeding experiments tend to show that when a stock is bred for draught purposes, its milk-yielding capacity diminishes in consequence. The capacity to yield excessive milk and the stamina for cart work do not seem to go well together. Separate farms should, therefore, specialize in breeding cows for milk and for draught quality. If this will not be done, the danger or risk of promiscuous mating will always be there, because the herds will mix up at the time of grazing and many years of efforts in stock-raising will be marred by a few minutes of negligence.

In the past, there has been a tendency on the part of stock-owners and the Government Farms and Dairies to improve the milk-yielding capacity of their cattle by cross-breeding them with sires of reputed European breeds. Ayreshire and Angus bulls (Scottish) have been used for this purpose and the results obtained in the first crosses have no doubt been good and spectacular. But the succeeding generations have seldom come up to the reputation of the first crosses and have tended to fall off from their average performance. It is, therefore, obvious that only the F_1 can be depended upon for a high yield of milk. In-breeding of the F_1 generation has led to deficient results and back-crosses with the females of the indigenous stock have also yielded inferior results. The forward-crosses of F_1 females with Ayreshire bulls yielded results of questionable value, and it appears that satisfactory results are to be obtained only from crossing the indigenous cows with Ayreshire bulls.

Two alternatives seem open to us. First, that a continuous and sustained effort be made to improve our local breeds by means of persistent selection. This would no doubt be a slow progress, and, what is more, an upper limit will soon be reached, according to Johannsen's Law of Pure Lines beyond which no further increase in the yield of milk by our stock will be possible. If selection is systematically carried out and inferior animals are rejected and not allowed to breed, then the situation will undoubtedly be considerably better than what it is now. The yield of milk depends upon climatic factors, conditions of grazing, kind of fodder given, and the care and attention bestowed upon the animal. While the genetical factors are responsible for the general capacity and constitution of the animal, nurture is not to be neglected if the inherited genetical factors are to play their part in full. Selectivity, by which I mean elimination of the unfit and the use of sires and dams of known worth, will give ample scope to the inherited characters not only to perpetuate themselves but also to express themselves in the fullest measure. It is fair to blossom forth for want of adequate attention, and random breeding and free matings have levelled down our stock to an abject

condition. It is, therefore, rightly argued by some of the experts that importation of foreign blood in our herds is unnecessary, and may even introduce unforeseen complications, and that sufficient potency is lying hidden in them which has not had an opportunity yet to express itself. The indigenous stock, if and when properly raised, will have the additional advantage of being perfectly suited to the local conditions of climate, temperature and will be able to resist the diseases better than the cross-breeds.

Secondly, it is open to us to improve our stock by using the imported Ayreshire bulls which will give us F_1 females of high milk-yielding capacity. But this advantage will be more than outweighed by the disadvantages that these half crosses will be intolerant of the climate and temperature, more susceptible to diseases and liable to deteriorate in vigour as well as milk-yield, if further inbred or lined with Ayreshire bulls in the succeeding generations. The other complications that will be introduced by pursuing this policy will arise out of the fodder problem of these half-breds. Their digestive capacity will be ill-adapted to our poor and dry fodder and it will become necessary to grow other kinds of fodder for them. It may even become necessary to grow Berseem and other American fodder grasses here, to prepare silage, and even to reserve large tracts of land as grazing facilities available in the country the cultivation of these European grasses in India will have to be done at the expense of other agricultural crops. So it seems to me that the second alternative is not likely to prove an unmixed blessing.

Maston has remarked that "the European cattle have been bred to carry those characters which assist in the effective use of the largest possible quantity of food, while the Indian cattle have been developed to make the most efficient use of the smallest quantity of food". Wright is convinced that "the general adoption of a policy of a cross-breeding to improve the yield of the country-stock would be fatal to the development of sound dairying in India". Hammond has remarked that "there can be little doubt that European stocks, even when bred pure, generally lose their type under these (tropical) conditions and require continual importations to maintain their form and constitution". Stockdale, writing about Nigeria, says that "in his opinion, a policy of rigid selection from the local cattle would be achieved by the introduction of blood from strains of cattle from outside".

The building up of high milk-yielding strains from the country-stock is undoubtedly a slow and laborious process, whereas cross-breeding with the European stock yields spectacular results in a short time in one single step. But there is no gainsaying the fact that the time and labour devoted to this problem will be well spent if one can succeed in building up milk-yielding strains from the country-stock. We can so plan the breeding work at different centres in the country that milk cattle suiting different purposes and pockets may become available to us. For instance, if it is desired to obtain cows of average milking capacity and bullocks hardy enough for plough work then nothing would be better than to cross the local country-stock with the Tharparker or Red Sindhi breed. These breeds have their home in the arid, semi-desert tracts of Sind and can tolerate high temperature, dry conditions, scarcity of water, dry fodder and other hardships. The people of Rajputana, therefore, cannot do better than cross-breed their cattle with Tharparker or Red Sindhi breed. Any other policy would be suicidal for them. Ayreshire, Montgomery and Angus half-breeds will not exist for long under such trying conditions.

Example 2: Again, if a poor man's breed is desired, then it would be better to cross-breed the Rath cows with the Red Sindhi or the Tharparker bull or *vice versa*. The resulting progeny will thrive well in areas where grazing facility is limited, only dry fodder in small quantity is available and nothing better than grain-crop residue is available for flavouring their feeds. These breeds have been exported in sufficient numbers to Burma, Ceylon, Malaya States, Japan and the Philippine Islands, where their value has been apparised better than at home.

Example 3: If, however, it is desired to obtain improved type of plough or trot animal, then, provided reasonable pasturage facilities and fodder is available the local stock should be crossed with the Ongole cattle of the Madras Presidency. The bullocks of this breed are large-sized, strong and powerful animals, and are well adapted for fast trotting or heavy plough work. Ongole cattle have been exported to tropical America in large numbers in order to size up the cattle herds there.

Example 4: The Nagore breed is well known for its trotting quality. The bullocks are big animals and have a reputation for fast road-work. In those places where there is a demand for powerful animals for road-work nothing would be better than no cross-breed the local stock with the Nagod, Ongole, Kankrej or Amritmahal cattle. This will give us all that we may look for; clean and strong limbs, compact build, muscularity, height on legs, breadth and power of endurance.

Example 5: If it is desired that the cart or the plough animals be not fiery but docile, then local stock should be cross-bred with the Kosi cattle.

Example 6: If it is desired to have a progeny consisting of good milk-yielders as well as good work animals (bullocks) then the local cattle should be cross-bred with the Hariana or Deoni stock. This will give us both good cows and transport or plough animals.

It is assumed that in making these experiments, only fit genotypes will be employed. This can be found out by analysing the results of twenty matings of a bull with his own daughters. If the progeny thus produced conforms to the specifications of the breed, then the bull may be assumed to be a fit genotype for breeding purpose. Without this precaution, the breeding results will be of doubtful value.

The Genetics of Cattle Breeding

(*a*) *Genetical Factors Influencing the Milk-yield.*—It is very important to know whether milk production depends upon hereditary factors or upon fodder and the care bestowed upon the cattle. Experiments in the heredity of milk production have been carried out only in the States Experiment Stations at Iowa and Maine in the U.S.A. The results obtained there show that while some bulls increase in the milk yield, others decrease it, which means that the *genotype* for yield of milk differs greatly in different bulls. The *phenotype* of milk production can only be observed in the cows and not in the bulls. A good practical rule is to find out by breeding a bull whose daughters show marked improvement in milk production and to use it as a sire as long as possible.

(*b*) *The Genetics of Butter-fat Content of Milk.*—It is important to know whether the butter-fat content is determined by hereditary factors, and, if so, how these factors act. It is common knowledge that some breeds of cows give rich milk, others thin milk.

Count Ahlefeldt-Laurvingen's experiments on Red Danish cows and Jersey bulls show that hereditary factors exist in Jersey cattle which are partially dominant over the hereditary factors for lower butter-fat percentage of the Red Danish cattle. From a study of numerous data it has been concluded that, in this case, the difference is due to the operation of a single Mendelian factor. But there are other cases on record which show that the butter-fat percentage is not determined solely by this factor alone but other hereditary factors are also concerned in it in certain breeds. The performance of bulls belonging to different breeds is different on different occasions, and, what is more, even the same bull produces different kinds of heifers from the same dam. Daughters of the same sire have been known to give milk of *a higher or lower* butter-fat percentage than their dams. Just as a bull may have a genotypic constitution for higher butter-fat content of the milk of their daughters, or grand-daughters, are compared with their dams or grand-dams. It seems that there are bulls possessing hereditary factors for both *high* and *low* butter-fat content in the milk, and that they are *heterozygous* for these factors.

(*c*) *Inbreeding of Cattle.*—Opinion is sharply divided on the relative merit of inbreeding and outbreeding. Some authors believe that inbreeding is essential for good results; others hold that inbreeding is itself harmful and should be avoided. It is only now that we are beginning to understand the effects and importance of inbreeding and it has been found that the oft-quoted bad results are due to the fact that the animals used in the process possessed such hereditary factors that their offspring tended to be homozygous for some hereditary factor responsible for diminishing vitality. For instance, Mohr and Wriedt's studies on the origin of bull-dog calves among Telemark cattle in Norway showed that the sire, *Niklas*, possessed a single Mendenian factor for bull-dog calves. The calves obtained from *Niklas* and normal cows had the genotype constitution N/N or N/*n*, where N stands for normal calves and *n* for bull-dog calves. Now, if the descendants of *Niklas* are mated together calves of the following constitution would result:

(*i*) N/N ..... Normal homozygotes.
(*ii*) N/*n* ..... Normal heterozygotes.
(*iii*) *n*/*n* ..... Bull-dog calves homozygotes.

Since the factor *n* for bull-dog behaves as a recessive to N, it is impossible to discover any phenotypic difference between those animals which receive the factor *n* in a single dose and those which do receive it at all.

In the case of calves having the constitution (*n*/*n*), inbreeding would be blamed for the evil effect produced, but it will not be readily recognised that the fault lay not with inbreeding as such but with the animals used. Bakewell, Colling brothers and Bates are well known for the success of their efforts in inbreeding. The modern English beef-breeds, Shorthorn, Aberdeen, Angus and others are the result of inbreeding and selection. Such examples of inbreeding among milking breeds are, however, less known. By means of intensive inbreeding great homogeneity of milk production has been secured in some Norwegian breed, *e.g.*, Guldros and Gardon pedigrees of Telemark cattle.

The genotype for milk yield is often present in the cow than in the bull. Sometimes one does, however, come across a bull which is homozygous in respect of the factors for large milk production and high percentage of butter-fat content. Such cases are, however, rare, and, even if one has such a bull on hand, it is difficult to find a successor to it.

The advantages of inbreeding lies in the fact that recessive lethal genes which are widely scattered in the herd will tend to combine and express themselves in the form of recessive homozygotes. Such calves will tend to become eliminated. *Paripassu*, the danger from indiscriminate out-breeding is that if a bull or bulls happen to harbour 'lethal genes' these would be transmitted to half the number of calves at each successive generation, and in this way, after sometime, the entire stick will or may become contaminated with recessive lethal factor or factors. It is, therefore, very essential to know the genotoype of those bulls that are selected as bull fathers in a herd of cattle stock. As a practical measure, it may be recommended that bulls that have given at least twenty normal calves in matings with their own daughters should be selected for breeding purpose.

The Fodder Problem

The fodder problem is an essential part of any large scheme of animal husbandry. Even as it is, the situation in India is very acute because the total number of cattle heads in India is out of all proportion to the fodder resources of the country. For instance, even in a small district like Benares, the milk cattle number 1,511,738 when the fully assessed area under cultivation is 531,193 acres and the population 1,016,378. From these figures alone the pressure on the land and the acuteness of the fodder problem can be envisaged. The cattle in India subsist mainly upon stubbles, grazing, 'Bhusa' (straw or hay) and

whatever roughage they can pick up by themselves. After the subsidence of the monsoon, the grazing facilities decline, and, during the hot season, the grasses are killed off by the heat of the sun and the cattle have to eke out a very hazardous existence. The bulk of the ryots are unable to produce sufficient food even for their own requirements so that their animals have to depend mostly upon stubbles, residue of crops and scanty grazing. The reported increase of 10 per cent. in the human population, during the last decade, as disclosed by the latest census report, is likely to worsen the situation still further. The conclusion is, therefore, forced upon us that if the Indian cattle are to be saved from a perilous situation then the fodder problem and the question of pasturage should engage our most serious attention. In India, one seldom comes across fine pastures as in the European countries, where acres of land exist solely for pasturage. Good natural grazing is available in this country only seasonally and that too seldom lasts longer than four months in the year. Reads is, therefore, right in saying that "the cattle spend the greater part of the year wandering about on the bare fields gathering a meagre livelihood". The term fodder crop is not understood in the same sense in India as in Europe. Really speaking, no crop is grown here to serve as fodder, and even when it is, it is first robbed off its grains and only dry stalks and leaves are chopped up and offered to the cattle. A crop so treated can hardly be called a fodder crop and cannot be quite as nutritious as when the grains had been left on the stalks. Fodder crops, when harvested with the seeds in the ears in the milk-stage and carefully cured in the sun, make admirable fodder for the cattle. So what with the shortage of grazing facilities and what with the absence of fodder crops and the scanty attention bestowed upon the animals by the owners, the cattle in India eke out a very slender existence.

A number of fodder crops have been grown and experimented upon in th past quarter of the century, and some of these can easily be grown by us for forage for our cattle.

TABLE XI

Some Important Fodder Crops

English name	Indian name	Scientific name		% (Green)
1. Egyptian clover ..	Berseem	*Trifolium alexandrian*	Rabi crop	18·38
2. Indian clover ..	Senji	*Melilotus pariflora*	,,	17·93
3. Clover ..	Shaftal	*Trifolium resupinatum*	,,	19·51
4. Oats ..	Jai, Jao	*Avena sativa*	,,	12·07
5. Field pea ..		*Pisum arvense*	,,	10·94
6. Rape and Mustard	Sarson, Rai	*Brassica campestris* and *B. juncea*	,,	13·44
7. Turnip ..	Shalgam	*Brassica rapa*	,,	1
8. Cow-pea ..	Chavli	*Vigna catiang*	Kharif crop	Not known
9. Cluster bean ..	Guara	*Cyamopsis psoralioides*	,,	11·99
10. Maize ..	Makai	*Zea Mays*	,,	8·31
11. Great millet ..	Juar	*Andropogun sorghum*	,,	7·38
12. Spiked millet ..	Bajra	*Pennisetum typhoideum*	,,	11·88
13. Buffalo grass ..	..	*Reana luxurians*	,,	7·27
14. Sudan grass ..	..	*Andropogun sorghum*	,,	4·13
15. Napier grass ..	..	*Pennisetum purpurium*	Perennial grass	4·56
16. Guinea grass ..	..	*Panicum maximum*	,,	5·31
17. Lucerne ..	Rizka	*Medicago sativa*	,,	18·46
18. Sun flower ..	Surajmukhi	*Helianthus annus*	Annual crop	12·63

MINERAL DEFICIENCY AND METABOLISM IN CATTLE

The role of nutrition in relation to various cattle problems is seldom adequately understood or appreciated, and yet it is one of supreme importance. The

results of scientific breeding and expensive maintenance at the studs may be completely vitiated if the dietary requirements of the cattle are not properly kept in view. The efficiency of a draught animal, or for the matter of that of a cow, is linked with the type of ration that is given to it. A good breed will deteriorate if kept on defective or insufficient ration, and the quality of milk will also vary accordingly to the quality of ration given to the cow.

Contagious bovine abortion, though not regarded to be due to nutritional disorders, has been known, for sometime past, to be conditioned by deficiency of lime or phosphorus, or both, in the ration. It has been shown by certain American workers that deficiency of lime in the diet produces abortion in cows or the birth of he-calf. The deficiency of lime is very common amongst stall-fed animals, because their ration, whilst rich in pasture is available to them for grazing or else a liberal quantity of lucerne or clover or silage is added to the ration. Lime deficiency, therefore, occurs where facilities for grazing are limited, and better types of fodder not available. The importance of grazing in the lives of the cattle will thus be obvious to us. Another important mineral which affects the fertility of domestic animals is phosphorus. It has been found that natural pastures in many parts of the world are highly deficient in this mineral and lead to a condition known as aphosphorosis. The animals get a depraved appetite, become prone to infectious diseases and turn sterile. The addition of substances rich in phosphorus in the diet, such as bone meal, improves their condition. It has been shown by experiments carried out in America and South Africa that phosphorus deficiency in cattle leads to a decrease in the milk yield. Cattle, which depend entirely or mostly upon grazing in India, receive a phosphorus-deficient diet and develop sterility to an alarming extent. Anæmia, goitre, rickets, œesteo-porosis, unthriftiness and starring coat, etc., are due to faulty metabolism due to lack of minerals. The problem of tuberculosis and Johne's disease in heavy milking cows is due to the deficiency of lime in the ration. There are some minerals which seem to have effect on breeding. Excess of flourine in the diet causes sterility. Iodine deficiency gives rise to goitre and breeding difficulties. Absence of vitamins A and E produces sterility or blindness in cows.

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